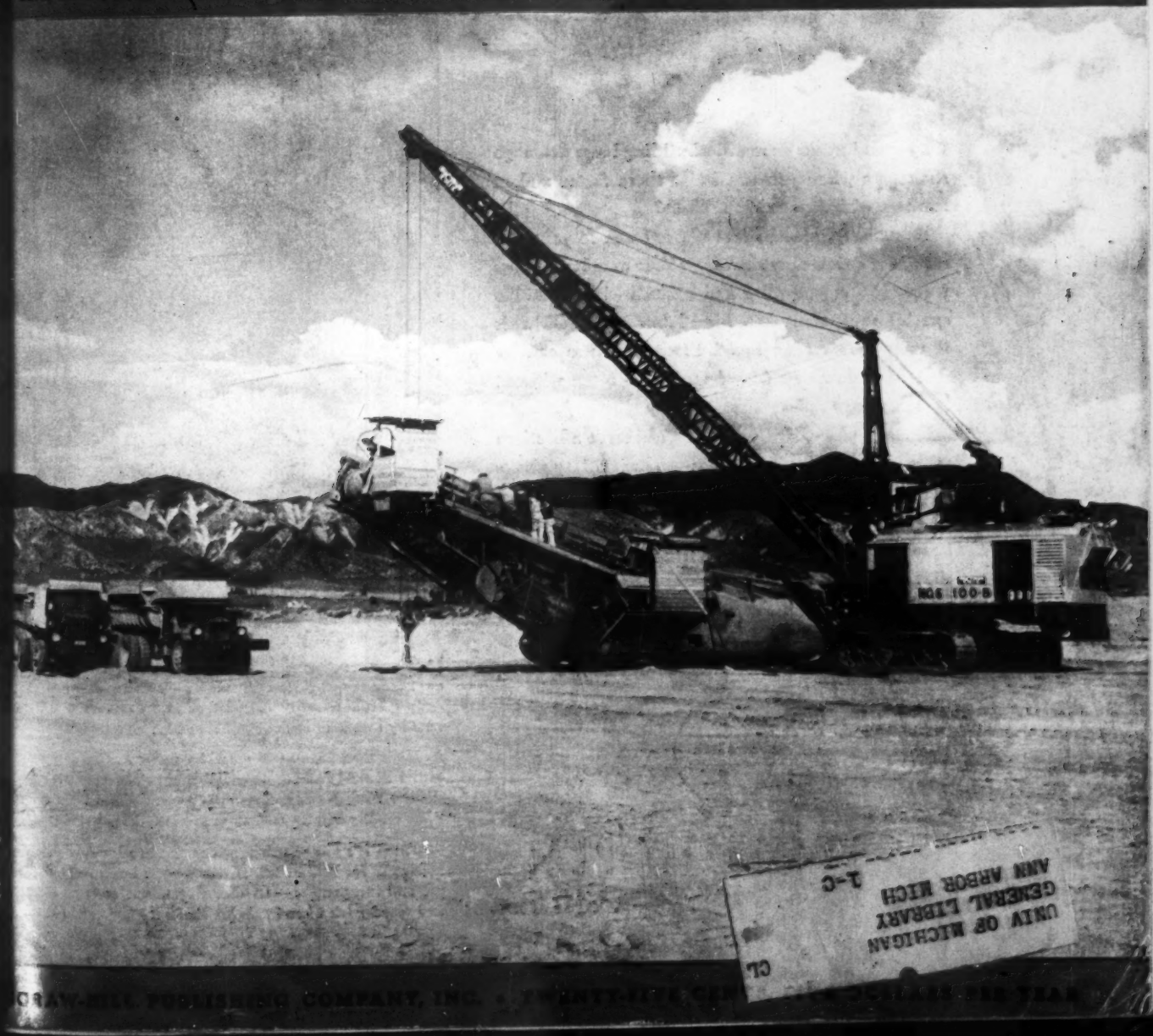
JUL 11 1939

E ENGINEERING CONSTRUCTION WEEKLY

ENGINEERING NEWS-RECORD

JULY 6, 1939

earth moving equipment used on Hoover Dam in California—see p. 42



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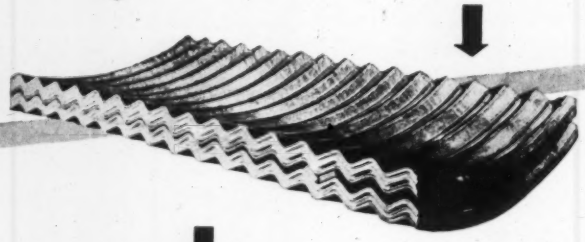

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Once in place, Multi Plate should serve a lifetime without maintenance because the heavy-duty plates are formed with extra large corrugations to withstand heavy loads and sudden impact. Then too the base metal is galvanized ARMCO Ingot Iron—an iron that already boasts a 33-year service record in gages much thinner than those used for Multi Plate. See your Armco representative for prices and information. Armco Culvert Mfrs. Assn., Middletown, Ohio.

MULTI ARMCO PLATE

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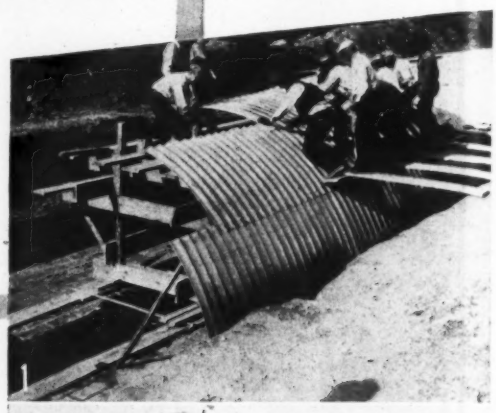

1. In constructing this large outfall sewer the engineer saved time and money by using an Armco Multi Plate arch anchored to a concrete base by means of unbalanced channels.

2. More than $6,000 was saved by using Armco Multi Plate Pipe for this 165-inch diameter siphon. Added safety is assured because Multi Plate readily adjusts itself to unstable soils.

3. Since it's the metal that carries the load, headwalls for Multi Plate structures can be simple and inexpensive — another way to cut costs and speed work when funds are limited.

Engineering Works

ENGINEERING NEWS-RECORD

Devoted to Buildings, Sewers, Waterworks, Bridges, Highways, Streets, Dams, Foundations, Earthwork, Flood Control, Public Works, Irrigations, Canals, Railroads

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THIS WEEK

● How quantity production in earth moving is being obtained at Hansen Dam is the subject of the lead article in this issue. Two new types of construction equipment are being used on their first large-scale operations.

● Badly cracked walls in many publicly financed housing projects of recent construction have been the subject of much criticism. On p. 45, F. N. Severud tells why the walls cracked and how to avoid cracking.

● One of the most notable bridge foundation jobs of recent times is described on p. 47. Floating cofferdams were used repeatedly for the pier bases and part of each pier was floated in as a cofferdam.

● Details of the Attorney General's plans for an investigation of the construction industry are given on p. 52. If they are followed out, no part of the industry will escape a critical study of the practices.

● Fill disposal of refuse continues as a controversial question. Details of experience at San Francisco are given on p. 59 and results of a new form of treatment for such fills are outlined on p. 58.

● How a difficult hydraulic problem of distribution of water from an irrigation reservoir was solved is told on p. 61. An ingenious arrangement of spillways and gates gives adequate control for varying conditions of flow.

THINGS TO COME

HOW LOWER COSTS are now being achieved on so-called low-cost housing is outlined in an article to be published in the July 20 issue.

Other coming articles include one on contractor's liability problems written by an experienced insurance underwriter and two articles on tools and methods for underground exploration.

AN INDEX to Volume 122, January–June, 1939, will be published with the July 20 issue.

Thomas McQueen, Inc., contractor for sub-structure and Superior Concrete Construction Co., contractor for floor system, used approximately 650 tons of Ryerson Reinforcing Bars; also necessary bar accessories.

Completed . . On Time

Ryerson Reinforcing Cut, Bent and Delivered on the Job as Needed

Approximately 650 tons of Ryerson reinforcing steel were used in the retaining walls, piers, abutments, and bridge floor slabs of the recently completed Ogden Avenue over-pass on Chicago's west side.

The builders of this fine structure, along with thousands of other contractors, have learned to regard Ryerson as a dependable source for every steel need. Large stocks of uniform high quality steel products, experienced crews, complete cutting and forming equipment, and special dispatching methods, assure delivery according to exact specifications—and on scheduled time.

Our special Contractors and Builders Division will be glad to work with you on your next job. Whether your problem is one of intricacy of design, large or small tonnage, special service, or limited time, a Ryerson engineer can probably save you time and money. Get in touch with the Ryerson plant nearest you.

Joseph T. Ryerson & Son, Inc. Plants at: Chicago, Milwaukee, St. Louis, Cincinnati, Detroit, Cleveland, Buffalo, Boston, Philadelphia, Jersey City.

RYERSON CERTIFIED STEELS

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CONTRACTS AND CAPITAL

ENR CONSTRUCTION VOLUME AND NEW CAPITAL . . . FHA MORTGAGES

(,000 omitted)	June 1938 (5 wks.)	June 1939 (5 wks.)	% Change	Six Months 1938 (26 wks.)	Six Months 1939 (26 wks.)	% Change
Total	$223,066	$262,395	+18.0	$1,254,931	$1,557,224	+24.0
Private	49,158	54,509	+11.0	487,501	384,148	−21.0
Public	173,908	207,886	+19.0	767,430	1,173,076	+53.0
Federal	21,540	47,136	+119.0	119,921	150,419	+25.0
Total New Productive Capital	$504,566	$116,632	−77.0	$1,069,452	$951,186	−11.0
Private Investment	170,742	50,782	−70.0	529,897	447,162	−16.0
Federal (non-federal work)	284,771	65,850	−77.0	403,970	192,597	−52.0
Federal (federal work)	49,053	.....	.....	135,585	311,427	+130.0
FHA Mortgages Selected for Appraisal	$97,232	113,045*	+16.0	$455,248	602,271	+32.0

* *Preliminary.*

CONSTRUCTION COSTS . . . WAGE RATES . . . PRICES

	July 1938	July 1939	% Change	Change June to July 1938 June	1938 July	1938 %	Change June to July 1939 June	1939 July	1939 %
E N R Construction Cost Index, 1913 = 100	232.29	234.94	+1.2	236.86	232.29	−1.9	235.02	234.94	0
E N R Building Cost Index, 1913 = 100	194.39	196.78	+1.1	198.22	194.39	−1.9	196.41	196.78	+0.2
ENR 20-CITIES' AVERAGE									
Common Labor	$0.677	$0.684	+1.0	$0.677	$0.677	0	$0.684	$0.684	0
Skilled Labor (Av. 3 Trades)	1.426	1.444	+1.3	1.415	1.426	+0.8	1.436	1.444	+0.6
Bricklayers	1.519	1.538	+1.2	1.511	1.519	+0.5	1.514	1.538	+1.6
Struct. Ironworkers	1.473	1.499	+1.8	1.460	1.473	+0.9	1.499	1.499	0
Carpenters	1.288	1.296	+0.6	1.275	1.288	+1.0	1.296	1.296	0
Cement, per bbl	$2.55	$2.60	+2.0	$2.55	$2.55	0	$2.60	$2.60	0
Reinforcing Steel, cwt	2.69	2.45	−8.9	2.86	2.69	−5.9	2.45	2.45	0
Struct. Steel, Pitts	2.10	2.10	0	2.25	2.10	−6.7	2.10	2.10	0
Sand, per ton	1.25	1.21	−3.2	1.27	1.25	−1.6	1.23	1.21	−1.6
Lumber, 2x4 Fir, per M ft	31.32	32.38	+3.4	31.49	31.32	−0.5	32.22	32.38	+0.5
Lumber, 2x4 Pine per M ft	27.62	28.86	+4.5	27.47	27.62	−0.5	29.15	28.86	−1.0
Brick, common, per M	13.79	14.24	+3.3	14.14	13.79	−2.5	14.26	14.24	−0.1
Ready-mixed Concrete, c.y.	7.20	7.09	−1.5	7.19	7.20	+0.1	7.11	7.09	−0.3
Struct. Clay Tile, 3x12x12	74.32	74.27	−0.1	73.74	74.32	+0.8	74.27	74.27	0
Paving Asphalt, carn, ton	15.64	13.94	−10.8	16.05	15.64	−2.6	13.94	13.94	0

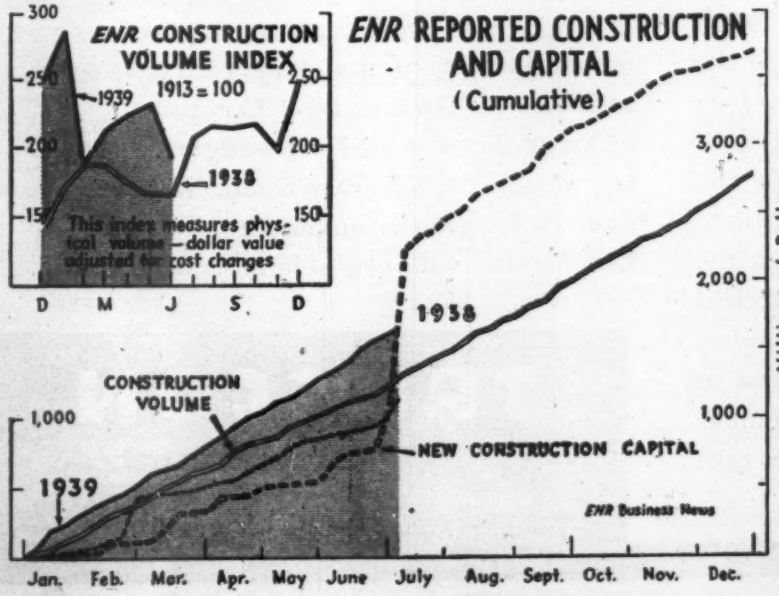
MATERIAL SHIPMENTS . . . BUILDING PERMITS

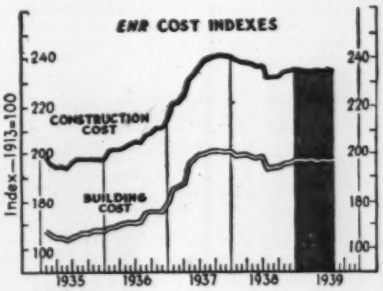
	June 1938	June 1939	% Change	May 1939	% Change May–June
Lumber (% 1929 wk. aver.) N.L.M.A.	55.0	69.3	+26.0	70.3	−1.3
Steel (% operating capacity) A.I.S.I.	48.3	54.2	+12.2	27.5	+96.8

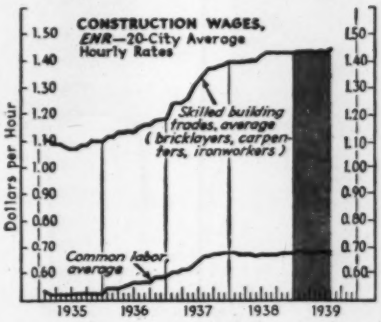
	May 1938	May 1939	% Change	Five Months 1938	Five Months 1939	% Change
Fabricated Struct. Steel, tons, A.I.S.C.	96,439	120,453	+25.0	468,701	532,633	+13.6
Cement, thous. bbl., U.S.B. of M	9,752	12,688	+30.0	34,667	41,942	+20.0
Building Permits, (,000 omitted), Dun & Bradstreet	$77,606	$111,508	+43.7	$439,924	$500,477	+13.8

RENT INDEX . . . EMPLOYMENT

	May 1938	May 1939	% Change	April 1939	% Change Apr.–May
Rent (Housing) Index, N.I.C.B.	87.0	86.2	−0.9	86.2	0
All Trade Unions, % Employed, A.F.L.	81.0	88.0	+8.6	87.0	+1.2
Building Trades, % Employed, A.F.L.	63.0	75.0	+19.0	71.0	+5.6






CONSTRUCTION WAGES, ENR—20-City Average Hourly Rates
Dollars per Hour
Skilled building trades, average (bricklayers, carpenters, ironworkers)
Common labor, average
1935 1936 1937 1938 1939

CONTRACTS

(Thousands of dollars)

	Week Ending July 7 1938	June 29 1939	July 6 1939
Federal	$38,675	$5,836	$8,070
State & Municipal	31,547	27,547	22,007
Total public	$70,222	$33,383	$30,077
Total private	8,100	8,517	7,472
TOTALS	$78,322	$41,900	$37,549
Cumulative 1939 (27 weeks)			$1,594,773
1938 (27 weeks)			$1,333,253

Note: Minimum size projects included are: Waterworks and waterways projects, $15,000; other public works, $25,000; industrial buildings, $40,000; other buildings, $150,000.

NEW PRODUCTIVE CAPITAL

	Cumulative 1938 27 Wk.	1939 27 Wk.
NON-FEDERAL	$1,155,725	$787,449
Corporate securities	191,938	130,755
State & Mun. bonds	353,410	329,097
R.E.A. loans	400	43,732
R.F.C. loans	64,891	2,446
P.W.A. allotments	232,516	.....
U.S.H.A. loans	111,070	146,419
Federal Aid—Highway	201,500	135,000
FEDERAL	$1,068,032	$311,427
TOTAL CAPITAL	$2,223,757	$1,098,876

FHA MORTGAGES

	Week Ending July 2 1938	June 24 1939	July 1 1939
Selected for appraisal	$23,130		$23,000
Cumulative 1939 (26 weeks)			$602,271

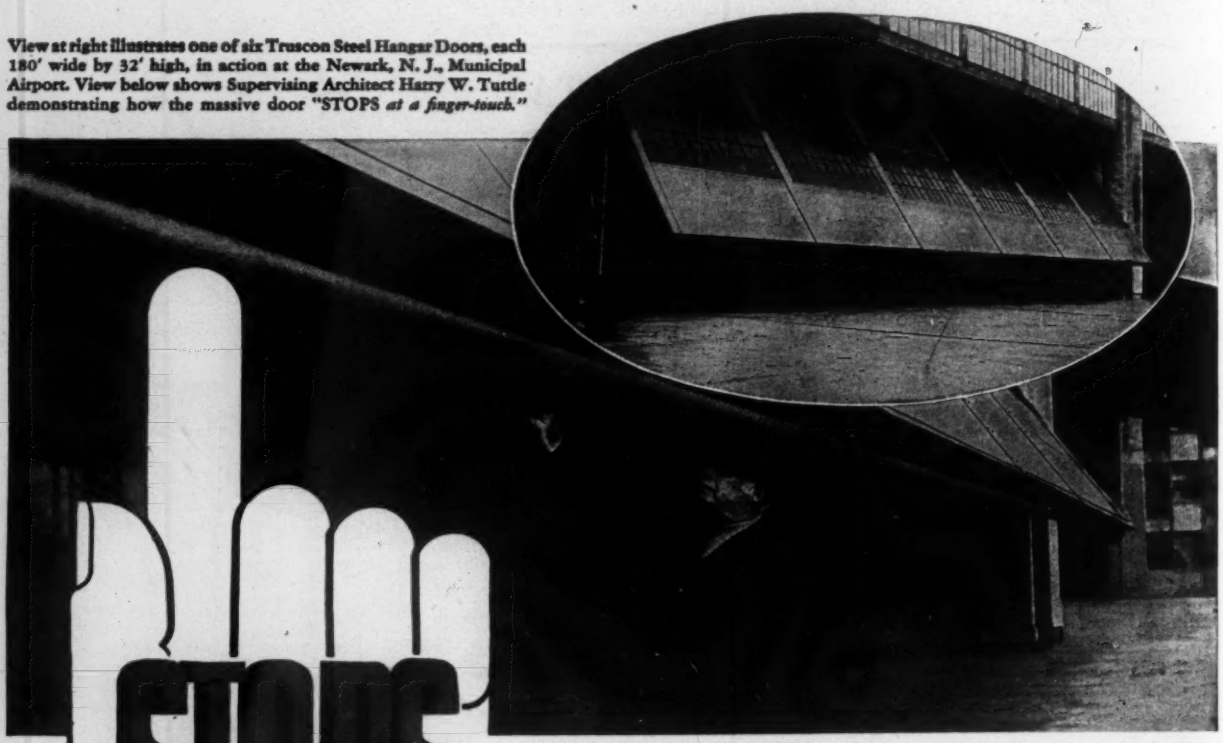
* Subject to revision.

ENR INDEX NUMBERS

Base = 100	Construction Cost 1913	1926	Building Cost '13	'26	Volume '13	'26
July, 1939	234.94	112.94	196.78	106.37	...	...
June, 1939	235.02	112.97	196.41	106.17	193	84
May, 1939	234.69	112.82	196.60	106.28	232	102
July, 1938	232.29	111.66	194.39	105.08	207	91
June, 1938	236.86	113.86	198.22	107.15	166	73
1938 (Av.)	235.86	113.34	196.83	106.40	197	86
1937 (Av.)	234.71	112.66	196.15	106.07	172	75
1933 (Av.)	206.42	99.15	172.18	93.14	185	81
1935 (Av.)	196.44	94.43	165.76	89.65	134	59

June Construction Table on page 38

View at right illustrates one of six Truscon Steel Hangar Doors, each 180' wide by 32' high, in action at the Newark, N. J., Municipal Airport. View below shows Supervising Architect Harry W. Tuttle demonstrating how the massive door "STOPS *at a finger-touch.*"



STOPS *at a finger-touch*

THIS TRUSCON STEEL HANGAR DOOR PROTECTS 'PLANES FROM DAMAGE

● Up go the massive Truscon doors of steel and glass as airplanes move in and out of the Newark, N. J. Municipal Airport hangars. • What happens if a costly plane bumps the bottom edge of a moving door? At the instant of impact, the big door stops dead! • So sensitive is the unique safety device running along the bottom edge of the door that the slightest touch makes an electrical contact which actuates the mechanism that stops the door. • In addition to this safety feature, the Truscon Hangar Door illustrated opens and closes rapidly thereby minimizing heat loss from the building in cold weather. • Engineering industrial steel doors of every description to meet exacting requirements is one of many specialized activities of Truscon Steel Company. • One of Truscon's 57 sales-engineering offices is within easy reach. Write us if its location is unknown to you. Our service will begin immediately.

TRUSCON *Steel company*

57 SALES ENGINEERING OFFICES · 29 WAREHOUSES

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ENGINEERING NEWS-RECORD

NEWS

Volume 123 JULY 6, 1939 Number 1

Prevailing Wage Out of Relief Act

New relief bill as passed by Congress requires all to work for 130 hours a month

Payment of hourly wages to relief workers at the prevailing rate for corresponding trades ceased on June 30 under the provisions of the 1940 relief bill which went to the President late that evening as the federal fiscal year 1939 closed. This requirement, written into earlier relief acts at the request of organized labor, has been a major source of trouble for the construction industry and has complicated the work of those charged with the direction of relief operations.

Details of the bill

The relief bill carries a total of $1,755,600,000 for the fiscal year just beginning. The bulk of this goes to the new Works Progress Administration in the new Federal Works Agency, its share being $1,477,000,000. Other items of interest to the construction industry are: $7,000,000 for the Puerto Rico Reconstruction Administration, $14,500,000 to the Treasury, $300,000 to the Public Health Service and $750,000 to the National Resources Planning Board. The act requires that all persons who have been on relief 18 months or more by Aug. 31 shall be dropped but can be reemployed after 30 days if they have not obtained other work.

Wage requirements

Regional wage differentials, now paid under the present act, are eliminated. What the new subsistence wage will be has yet to be determined. With few exceptions, all employees will have to work 130 hours a month at rates set by the WPA. Elimination of the prevailing wage requirement will call for a complete revision of rates paid the skilled trades. Up to 10 per cent of men not on relief can be employed where skilled help is needed.

Contributions to non-federal projects are limited to $52,000. Sponsors for such projects will be required to contribute 25 per cent of the cost, but the Commissioner of Works Projects may determine the form in which this contribution is to be made.

N. Y. U. CIVIL ENGINEERING HEAD

Harold Everett Wessman has been appointed chairman of the department of civil engineering in the College of Engineering at New York University. Wessman has been acting chairman for the past year. He joined the N. Y. U. staff as professor of structural engineering in September 1937 and previous to that time had been associate professor at the State University of Iowa. His earlier experience includes service with Wadell and Hardesty, New York consulting engineers, and teaching in China.

Large Cut Urged In Housing Costs

Cut of twenty per cent proposed before first hearing of the National Economic Committee.

Gearing construction activities to today's biggest market—housing for the low-income groups—and cutting the costs of building to meet this market were the two major questions discussed at the fact-finding hearings before the National Economic Committee which began in Washington on June 27. Both of these questions were considered vital in removing the obstacles to recovery of the construction industry.

Under the item of costs, Joseph J. O'Connell, special counsel for the committee in its study on the construction industry, stressed the fact that a nation-wide investigation of price-fixing combinations in the building trades is already underway by the Department of Justice. Certain phases of the monopolistic practices were elaborated upon by a Chicago builder of small homes—Carleton A. Smith of Smith and Dawson—who was questioned by Senator William H. King of Utah, by O'Connell, the committee counsel, and by Leon Henderson, the new head of the Securities and Exchange Commission. After Smith's testimony, Senator King remarked, "I hope that that matter will be covered before this investigation closes, because the testimony given this morning and from information which has been brought to my attention, there seem to be, I will not say conspiracy, but organizations which are promoting monopolistic practices in the building-trade activities"

The need for a 20 per cent reduction in home-building costs for the low-income groups was discussed at

(*Continued on page 35*)

Public Works Head Resigns in Kansas City

Matthew S. Murray, Kansas City director of public works, resigned June 20 after Mayor Smith had ordered him to give up either his city job or his post as Missouri State Administrator of the WPA. N. W. Hyland, assistant director, was placed in charge of the department pending the appointment of a successor.

Murray, who held a prominent position in the old Pendergast democratic machine has held the public works post since 1926; earlier he was an engineer for the state highway department. Charles A. Haskins, well known consulting engineer in Kansas City has been mentioned for Murray's job.

On June 29, Henry F. McElroy, Pendergast city manager, was indicted in connection with a $356,000 city water scandal. Also indicted were J. S. Rathford and J. J. Pryor. Rathford was head of a dummy engineering firm which was supposed to make water main leak surveys at a fee of $5,000 a month.

• • •

Niagara Bridge Commission Seeks to Keep Project Alive

Following President Roosevelt's veto of a bill extending the time in which a start must be made on construction of a bridge to replace the Falls View Bridge at Niagara, the Niagara Falls Bridge Commission immediately began to seek ways for keeping the project alive. The President vetoed the bill on the ground that the act which it extended provided that the bridge bond and the bridge revenue should be tax exempt. President Roosevelt expressed himself as opposed to tax-exempt bonds for such projects.

The present plan of the bridge commission is to ask the district engineer, U. S. Army, whether the borings for the new bridge, which were made before June 16, the date set for start of work, constituted actual start of construction. If so, no further legislation is needed.

C. Ellison Kaumeyer, secretary of the commission, states that the commission has approved both the design and specifications for the bridge and will be ready to start soon after the financing is arranged.

Fairchild Aerial Surveys

JERSEY APPROACH TO LINCOLN TUNNEL DEDICATED LAST WEEK

WITH THE OPENING of the express approach to the New Jersey end of the Lincoln Tunnel between Midtown Manhattan and Weehawken, N. J., it is no longer necessary for motorists to find their way through local traffic between the Hudson and the highways on the Hackensack Meadows.

A motorist coming from New York in the tunnel turns left before emerging from underground and makes the long loop in the foreground to rise to the depressed roadway across the top of the Palisades. The numerous grade separations of Weehawken, Union City and North Bergen, N. J. are visible in the right-hand part of the picture. In the distance can be seen road and connections across the low Hackensack Meadows, and in addition there is a connection to the state highway which runs along the far border of the cities.

At the present time fourteen motor bus firms are running twenty lines or about 1,700 buses through the Lincoln Tunnel between Manhattan and Weehawken, daily.

Cut in Housing Costs

(*Continued from p. 33*)

length by L. Seth Schnitman, consulting economist, and by Robert L. Davison, director of housing research of the John B. Pierce Foundation, both of New York.

The anti-trust question came up after C. A. Smith, the Chicago witness, testified on material costs. Smith explained the operating relations of the builder in Cook County, Illinois, with the association of retailers called the Material Merchants Association. He said that the builder in that section must buy, through an association yard, products such as sand, gravel, cement, mortar and tile. In reply to Senator King's questioning, Mr. Smith said that there is no competition among these retailers.

Mr. Smith also testified that union regulations required that work such as plumbing, heating and plastering (which includes lathing and glazing) must be let out as sub-contracts. The master plumber,' he said, or master electrician, buys his own material from the yards of the association and supplies his own men.

Smith admitted that he could purchase products and hire men considerably cheaper, if it were not for the restrictions of the regulations.

With regard to the reduction of building costs, Schnitman stated: "It seems to be the opinion in the construction industry that anything short of a 20 per cent reduction would be rather inconsequential." The 20 per cent reduction, which Schnitman said is an arbitrary figure, also was discussed by Davison of John B. Pierce Foundation. He said that while a 20 per cent reduction in labor costs would reduce the monthly rental only 4.67 per cent, and the same cut in materials would reduce rental only 9.3 per cent, the 20 per cent reduction in interest on mortgage and amortization would reduce rentals 16.69 per cent.

That a vast, long-range program to build low-priced housing should be launched was the contention made by Isador Lubin, commissioner of labor statistics, Department of Labor. He proposed as a minimum goal for such a program, 525,000 houses per year, during the next ten years. A conservative program, Lubin pointed out, compared with that of 1925 when 937,000 houses were built, but a worth-while increase over the present-day home-building activities. Last year, he stated, only 345,000 houses were built and during the last nine years, an average of only 190,000 were built per year. At least half of the 525,000 houses, Lubin said, must cost less than $4,000 if they are to be made available to the low-income groups who need them most.

JULIAN C. SMITH

Julian C. Smith, president of the Shawinigan Water and Power Co., died in Westmount, Quebec, June 24 at the age of 61 (*ENR* June 29, 1939). After his graduation from Cornell University in 1900, he joined Shawinigan in 1903. Concurrent with his Shawinigan service, he was president of Montreal Tramways Co., and vice president and a director of the Dominion Bridge Co., Ltd., and Engineering Works, Ltd. He was a member of the Am. Soc. C.E.

• • •

Bids Are Asked On Friant Dam

A call for bids for the construction of Friant Dam, the second major structure in the Central Valley project in California, has been announced by the Bureau of Reclamation. Although a few preliminary details must be cleared away before construction can begin, it is believed that work can start within 60 days and that it will take at least that long to receive bids and award contracts.

The dam, to be constructed on the San Joaquin River, east of Fresno, will be of concrete gravity type, 300 ft. high and 3,430 ft. long. It will require about 770,000 cu.yd. of excavation and placement of 1,905,800 cu.yd. of concrete. The dam will create a reservoir with a total storage capacity of 512,500 acre-ft., of which 70,000 will be reserved for flood reduction and 316,500 acre-ft. will be stored for irrigation.

A contract recently was completed by which the United States obtained title to the Friant Dam site and some gravel lands from which concrete aggregates will come.

Roy B. Williams, former assistant engineer of the Bureau of Reclamation will be construction engineer.

OBITUARY

WILLIAM B. SHAFER, 63, construction engineer of the Pittsburgh City Refuse Division, died suddenly in Chicago, June 26, while on a trip to that city investigating refuse equipment. Graduated from Cornell University in 1898 his early years were in the general contracting business in New York and Philadelphia. In 1933 he was appointed superintendent of the Pittsburgh Bureau of Highways and Sewers, a position he held until recently. He was a member of the Board of Directors of the American Public Works Association.

JOHN H. BOOS, JR., died June 30 in St. Louis at the age of 37.

JAMES WHITELAW, bridge engineer for the Canadian National Railway, died June 27 at the age of 59. Born in Scotland, he came to Canada 28 years ago, joining the old Grand Trunk Railroad as a civil engineer at that time.

JOHN S. EKEY, engineer of bridges and buildings for the Bessemer & Lake Erie Railroad, died at Greenville, Pa., June 3. He was born in Parker, Pa. in 1879 and began his railway career in 1902 with the Pittsburgh and Lake Erie Railroad. Later he was in the engineering department of the city of Pittsburgh and in 1916 became supervisor of structures of the Bessemer & Lake Erie, being promoted to engineer of bridges and buildings in 1931.

RALPH W. WARDELL, 60, former captain of engineers of the U. S. Army and a civilian employee of the Providence, R. I. office for the past few months, died at his home in that city on June 28.

HUGH EDWARD WHITE, Sr., 69 years of age, died in Gastonia, N. C., June 25. He had been an architect with the Treasury Department for 15 years.

CHARLES F. MOORE, 54, general contractor for 20 years, died June 26 in Cleveland.

EDWARD C. DUTTON, 58, a civil engineer and Smyth County surveyor, died June 23 in Marion, Va.

ROBERT A. BOND, an engineer with the Elizabeth, N. J. Water Co., died June 28 in Union, N. J.

MICHAEL F. STOKES, 70 years of age, Buffalo, N. Y. building contractor, died June 22.

WILLIAM E. LENANE, 77, a Detroit paving contractor and builder, died there June 16.

HARRY R. PEARSON, 53, TVA chief right of way engineer, died June 17 in Memphis.

Materials Specifications and Tests Given Annual Overhauling

Action on specifications and discussions of unexplored properties of materials feature 42nd annual A.S.T.M. meeting

In one of the largest meetings of its history the American Society for Testing Materials last week at Atlantic City celebrated the 42nd anniversary of its foundation in 1898. In addition to regular technical discussion and committee reports the meeting included eight special conferences dealing with unexplored properties of materials and specially difficult tests, in such fields as paint, weathering, radiographic testing, and shear testing of soils. Because of publication of the triennial book of standards this fall the specification work reported by technical committees was of exceptionally large volume, and more than 200 committee sessions were held during the week. An exhibit of testing machines and related equipment, held in conjunction with the meeting, brought together some 30 individual exhibits. H. H. Morgan of the Robert W. Hunt Co., Chicago, was elected president.

A new publishing plan for the society's standards was announced at the meeting. The publication of standards and tentative standards in separate volumes, respectively triennial and annual, will be replaced by triennial publication of both standards and tentative standards, arranged in three volumes covering metals, non-metallic construction materials and other non-metallic materials.

Prof. Roy W. Carlson, Massachusetts Institute of Technology, was awarded the Dudley Medal for the best research paper contributed during the past year, "Drying Shrinkage of Concrete as Affected by Many Factors."

Delbridge and Moore addresses

Retiring president T. G. Delbridge in his presidential address, "Glimpses at Petroleum," in speaking of the available petroleum supplies, said that while the most authoritative predictions of 20 years ago indicated a supply that would have been exhausted long before now, the present supplies of petroleum may be expected to last for at least 150 years.

Prof. H. F. Moore, of Illinois, in the Edgar Marburg lecture discussed "Stress, Strain and Structural Damage" in relation to the service and properties of materials. He showed that our present fundamental concepts of the behavior of materials and structural parts are almost as faulty as those of Galileo but that they are adequate for practical purposes when properly applied. However, these concepts take account only of elastic action, whereas, in Prof. Moore's words, "If it were not for the relief of stress by localized inelastic action it would be very doubtful whether our structural and machine parts would stand up in service." The lecturer then discussed in detail the problems of measuring resistance to four kinds of failure, that resulting from elastic deformation, from inelastic action, from fracture, and from creep, bringing out in each instance the wide range of unknowns.

Important papers and committee reports are reserved for abstract in our July 20 issue but specification changes and other technical developments of the convention are detailed below.

Steel specifications

Specification work of the steel committee during the past year was concerned largely with steels for high temperature and high pressure service, and with numerous minor revisions in railway spring standards. It, however, did not entirely neglect civil engineering materials since its action in securing approval of a single consolidated standard specification for bridge and building steel to be designated A-7 and to take the place of A-7 (steel for bridges) and A-9 (steel for buildings) was one of the most important developments of the convention. The net effect of the change is to raise building steel requirements to those now existing for bridge steels, i.e., phosphoros content is reduced from 0.06 to 0.04 per cent (except for Bessemer, 0.10); sulphur is limited to 0.05 per cent; elongation in 8 in. is increased by 7 per cent; and the bend test is made the same as for bridge steel. Under the new specification openhearth or electric-furnace steel must be used, except that plates or shapes ⅞ in. or less in thickness for static load structures may be made by the acid-Bessemer process.

A change in another specification of consequence—high strength structural rivet steel—was the reduction of tensile strength from 70,000-85,000 lb. per sq.in. to 68,000-82,000. The original values were based on the "as-rolled" condition, whereas the rivet stock under the revision must be annealed. An important activity of the steel committee, to start soon, is a study of welding as related to low-alloy steels.

Metals-testing discussions developed several papers on properties of steels and non-ferrous materials at temperatures down to 300 F. below zero, which showed for most steels almost complete loss of impact resistance at temperatures of—50 to—75, but correction of the defect in certain cases through addition of nickel, molybdenum and vanadium, while non-ferrous alloys usually were found to maintain or increase their toughness at low temperatures. Full-size fatigue tests on axles reported by O. J. Horger and H. R. Niefert, Timken Roller Bearing Co. showed a substantial size effect, full-size axles having an endurance limit of only 17,500, as against 33,000 for specimens 0.3 in. in diameter machined from the same steel.

Cast and wrought iron

Specification developments in the cast, wrought and malleable iron fields were of minor character. The cast iron committee reported that its sub-committee on soil pipe has completed a revised tentative specification to replace the existing standard of 1929. T. H. Wiggin reported for the joint committee of A. S. T. M., American Gas Association, American Water Works Association and the New England Water Works Association that the joint specifications for pitcast water pipe have just been printed and that the specifications for spun cement mortar lining of cast iron pipes will be completed soon. The specifications for special types of cast iron pipe (such as centrifugally cast) will be completed in a matter of three or four months. All of these specifications represent the culmination of nearly ten years of test and investigation. Specifications for fittings will be delayed some time because of lack of sufficient test data.

Corrosion of iron and steel

The report of the committee on corrosion of iron and steel was featured by voluminous reports of the first data from field tests of metallic coated agricultural wire; some 11,000 samples and eleven test locations are involved. The final reports on black sheets exposed at Annapolis and on riveted plates immersed in salt water at Portsmouth, N. H., and Key West, Fla., are scheduled for next year. Principal specification changes were in the field of metallic coated products for which two new tentative specifications were adopted covering zinc coated steel wire strand, with heavier coatings than called for in an existing specification, and a method of test for local thicknesses of electro-deposited coatings on steel, involving the microscopic method for zinc, cadmium, copper and nickel coatings

and a hydrochloric acid spot test method for chromium coatings.

In the field of non-ferrous metals a new specification covering a method of salt spray testing was adopted. An analysis of the results of atmospheric corrosion specimens at 1, 3 and 6-yr. periods on the basis of strength and elongation (the corrosion or weight change measurements having been found of little value) showed only a few materials with appreciable losses either in strength or ductility. Copper and copper alloys, aluminum and aluminum alloys, nickel and nickel-copper alloys, lead, antimony, tin and zinc were the materials involved. Losses where observed were greater in industrial and marine atmospheres than elsewhere.

Testing methods

In testing methods the two most significant developments were the positive steps taken in two of the convention symposiums to set up committees to deal with accelerated weathering tests of paints, asphalt roofing and similar products and with accelerating weathering tests of masonry materials such as concrete and clay products. Previously dealt with in rather routine manner and with small success so far as agreement or acceptance of results is concerned, it is believed that the new plan will cause these compelling subjects to receive the attention they deserve.

It was reported that a special committee is working toward a method of test for crushing strength of pipe to cover cast iron, drain tile, clay pipe and concrete pipe; at present each kind of pipe is considered separately. Rewriting of the methods of impact testing of metallic materials is also underway to make them more informative and less rigid.

Cement and concrete

Developments in cement specifications and testing were much less important than usually. After the committee by a vote of 22 to 20 had submitted a method of test for autoclave expansion of portland cement for adoption as a tentative standard, the convention, again by a close vote, declined to accept it and returned it to the committee for more study. Two new methods for determining free lime in portland cement were added to the tentative standard on chemical analysis; in one method chemically pure glycerol is used as an accelerator while in the other either barium chloride or sodium chloride can be used. As to committee work, study of test procedures on bleeding embraces the use of cement-water grouts, standard sand mortars and pebble concretes; values will be expressed in relative water capacity of the cement rather than in the amount of water gain or bleeding.

Numerous minor changes were made in concrete and concrete aggregate specifications but no new specifications were submitted. However, a proposed method of test for soundness of aggregate by the use of magnesium sulphate and a proposed method of test for organic impurities in sand by pH values were submitted for publication as information.

Bituminous materials

The committee on bituminous waterproofing and roofing materials presented two new tentative standards covering asphalt mastic waterproofing, and an accelerated weathering test of bituminous materials. The waterproofing specification, which is a combination of three existing specifications, covers asphalt cement, mineral filler and mineral aggregate which are mixed together at the site. The apparatus recommended for accelerated weathering tests consists of an open metal cylinder 30 in. in diameter and 15 in. deep equipped with slots or hoops to hold the test specimens and connected with a revolving mechanism geared to furnish one revolution in 20 minutes. A carbon-arc lamp and a rotary sprinkler are installed within the cylinder to provide conditions similar to sunshine and rain. Auxiliary equipment includes temperature control and a refrigerator for creating freezing conditions.

Masonry units

A new specification was approved for solid load-bearing concrete masonry units (concrete block or tile unit with 75 per cent or more net area), which recognizes two grades, A and B, having an average minimum compressive strength of 1,800 and 1,200 lb. per sq.in., respectively. In case cinder aggregate is used, the combustible content shall not exceed 35 per cent of the weight of the aggregate. Another important development in the masonry field was the presentation of a primer on specifications and tests for masonry mortar. In addition, a specification was adopted for aggregate for masonry mortar. Recommended maximum aggregate sizes are No. 4 sieve for joints ½ in. or thicker, No. 8 for average brick masonry joints, and No. 16 for use with units requiring extra thin joints.

In the field of lime the specification for quicklime in water treatment and the one for hydrated lime were combined into a single specification on lime for water treatment. In the standard method of testing gypsum and gypsum products the meeting approved the addition of an elutriation method for determining the wood fiber content.

Honored by the convention were H. F. Moore, who delivered the Marburg Lecture, and Roy W. Carlson, who received the Dudley Medal.

The several symposiums

As previously mentioned, the symposium on accelerated weathering testing, where discussions were informal and unscheduled, resulted in the formulation of plans for setting up research committees on the subjects. In the other symposiums, notably paint and soils, scheduled papers formed part of the program. The paint discussion brought out a method of comparing the texture of paints and enamels by filling material into tapered grooves in a metal slab and observing how it runs (E. W. Fasig, Lowe Bros. Co.); a test for stability of dipping coatings by stirring them to introduce air and then observing their evenness or streakiness in running down a vertical glass plate (J. K. Stewart and D. D. Rubek, Anderson-Prichard Oil Co.); and discovery of defects in the preparation of metal surfaces for painting, such as finger marks or moisture spots, by heating the coated article in a "cook box" (V. M. Darsey, Parker-Rust-Proof Co.); a cook box was also described by E. W. McMullen, Eagle-Picher Lead Co.

In the field of rubber an "oscillograph" was described to indicate resilience and damping of small compression blocks under a weighted oscillating lever (F. L. Yerzley, E. I. du Pont de Nemours & Co.).

The symposium on shear testing of soils brought out discussions of torsional shear tests on solid and hollow samples (M. J. Hvorsley, Harvard University), descriptions of triaxial test equipment, and a comparison of results of direct shear and triaxial load tests (D. W. Taylor, M.I.T.).

Queens Dump Problem To Be Studied by Five

Four public health authorities and a sanitary engineer were named by Dr. Thomas Parran, Jr., Surgeon General of the United States, to comprise the committee which will pass judgment on the land fill method of refuse disposal in New York City. (ENR, June 29, 1939, p. 873). Indictments brought against sanitation commission Wm. F. Carey and others have been dismissed.

The members of the committee appointed on July 2 are Dr. Eugene L. Bishop, director of health for TVA; Dr. Kenneth F. Maxcy, professor of epidemiology and bacteriology at Johns Hopkins University; Dr. Milton J. Rosenau, director of the division of public health of the school of medicine of the University of North Carolina; Dr. Huntington Williams, commissioner of health of Balitmore; and Ralph E. Tarbett, senior sanitary engineer of the United States Public Health Service.

Indiana Road Commission Makes Cut in Ranks

A shake-up in the Indiana Highway Commission, in which 86 men have been dismissed effective July 1, is attributed to a cut in the personnel service budget by the recent state assembly.

Most of the dismissals are in the clerical and low salaried jobs throughout the state, while headquarters dismissals are mainly in the testing laboratory and bureau of design and audit control. The stream gaging department has been eliminated entirely.

• • •

North Carolina Avoids Highway Diversion

North Carolina has found it unnecessary to divert $2,000,000 from its highway funds to general funds, as authorized by the last legislature, due to revenue collections from other sources exceeding estimates by $2,200,000. The North Carolina Highway and Public Works Commission had retained an extra surplus of $2,000,000 in order to be in position to provide that amount of money for the state's general fund.

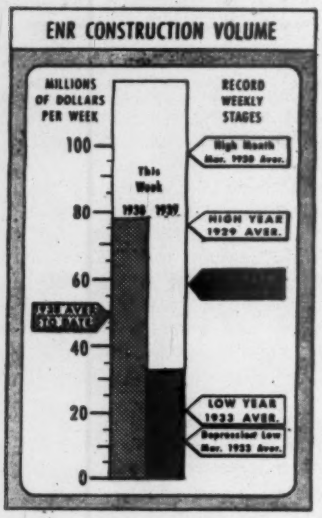
During the last two years North Carolina has made no diversion from its highway funds for use by other departments of the state's organization. The commission, however, has been obliged to keep a large surplus tied up in anticipation that diversion might be necessary.

Funds for highway purposes in North Carolina were increased $9,000,000 during the last biennium by order of the Governor, over and above the appropriations made by the state legislature. This sum has been used largely for the improvement of secondary roads and the modernizing of the primary highway system.

CONTRACTS AND CAPITAL

ENGINEERING construction awards for the short week due to the Fourth of July holiday total $37,549,000, 52 per cent below the volume for the corresponding week last year.

The current week's total brings the volume for 27 weeks of 1939 to $1,594,773,000, an increase of 20 per cent over the $1,333,253,000 reported for the corresponding period a year ago.



Private construction for the week is 8 per cent below the 1938 week, and public awards are 57 per cent below a year ago, when the contract was awarded for the Shasta Dam, a California Central Valley project.

In the classified construction groups, gains over last week are in waterworks, earthwork and drainage, and unclassified construction. Gains over the week last year are recorded in waterworks, industrial buildings, and public buildings.

New capital for construction purposes for the week totals $147,690,000, a decrease of 87 per cent from the 1938 week, in which federal departmental and relief appropriations were included. The current week's volume is made up of $135,000,000 in federal aid for highways, $8,199,000 in state and municipal bonds, and $4,491,000 in corporate security issues.

New financing for the year to date, $1,098,876,000, is 51 per cent lower than in the initial 27-week period last year.

ENGINEERING CONSTRUCTION CONTRACTS REPORTED BY ENGINEERING NEWS-RECORD, IN JUNE, 1939

Engineering News-Record *reports projects of the following minimum costs; — water-works, excavation, drainage and irrigation,* $15,000; *other public works,* $25,000; *industrial buildings,* $40,000; *other buildings,* $150,000.

Five Weeks — Thousands of Dollars (000 Omitted)

Public Works	New England	Middle Atlantic	South	Middle West	West of Mississippi	Far West	United States June 1939	United States Six Months 1939	United States Six Months 1938	Canada
Waterworks	959	2,365	1,197	526	1,656	804	7,507	112,263	47,691	171
Sewerage	1,793	4,482	1,970	4,930	1,978	108	15,261	96,058	52,456	121
Bridges, public	341	8,745	5,557	3,982	1,734	1,177	21,536	90,604	40,619	420
Earthwork and waterways	2,158	3,050	13,648	1,791	3,750	12,514	36,911	101,500	116,377	776
Streets and roads	2,463	19,750	9,020	20,036	13,864	3,742	68,875	339,534	271,907	4,714
Buildings, public	1,139	10,192	10,355	7,518	6,369	5,109	40,682	342,721	169,504	293
Unclassified, public	452	7,684	1,226	4,042	1,437	2,273	17,114	90,396	68,876	897
Total public	**9,305**	**56,268**	**42,973**	**42,825**	**30,788**	**25,727**	**207,886**	**1,173,076**	**767,430**	**7,392**
Federal government (included in above classification)	3,038	5,247	17,128	2,594	1,990	17,139	47,136	150,419	119,921	.....
Private										
Bridges, private	.....	25	.....	.....	26	.....	51	2,362	4,338	.....
Buildings, industrial	420	17,030	1,880	2,583	1,823	985	24,721	97,936	88,934	3,493
Buildings, commercial	1,250	11,380	2,806	2,310	2,490	1,320	21,556	185,550	345,895	1,614
Unclassified, private	225	655	1,337	2,101	3,190	673	8,181	98,300	48,334	381
Total private	**1,895**	**29,090**	**6,023**	**6,994**	**7,529**	**2,978**	**54,509**	**384,148**	**487,501**	**5,488**
Total Engineering Construction										
June, 1939 (5 weeks)	**11,200**	**85,358**	**48,996**	**49,819**	**38,317**	**28,705**	**262,395**	.....	.....	**12,880**
May, 1939 (4 weeks)	10,645	83,116	44,066	49,651	44,758	20,756	252,992	.....	.....	9,512
June, 1938 (5 weeks)	9,226	67,429	26,079	30,586	46,457	43,289	223,066	.....	.....	12,614
Six months — 1939	86,181	513,860	241,209	290,609	278,100	147,265	.....	1,557,224	.....	44,312
Six months — 1938	55,405	538,941	123,778	150,544	214,235	172,028	.....	.....	1,254,931	40,947

COMMENT AND DISCUSSION

Readers' opinions on matters that concern the engineer

The Property Owners' Side

Sir: The editorial "Tardy Protest" which appears in *Engineering News-Record*, June 8, p. 755, states or infers that

(a) The objections were not presented months ago.
(b) The low level as now proposed was determined by all the experts as the proper depth at which to build the subways.
(c) Work must go ahead without interruption and no time is available for stopping to consider whether the whole plan should once more be changed.
(d) To interrupt its progress on the strength of unsubstantial and possibly insincere objections would be a grave mistake.

We enclose copy of a letter sent by us on June 12, 1939, to Hon. Harold L. Ickes, Administrator of the Federal Emergency Administration of Public Works, which we believe will disclose to you facts that were not in your possession.

You will note that the present low-level plan has never been considered the proper depth by the city's engineers, by engineers of national reputation engaged by us, nor by any engineer whom we have consulted; that this position of the city's engineers has been constantly before the PWA since the inception of the project; that ample time is available for stopping to reconsider this question; and that the cost of the present plan is excessive.

With these facts before you, we are confident that you will appreciate the sincerity of the objections of the citizens group of Chicago.

JOHN T. PIRIE ARTHUR B. HALL
RUSSELL TYSON DARROW B. FULTON
State Street Council and Property Owners Committee on Subways
Chicago, Ill. *June 13, 1939*

The letter to Secretary Ickes that accompanied the committee's letter to the editor stated that the time required to build a high-level subway would be less than that required for the low-level route, despite delays due to changing plans, and gave cost figure indicating a saving of over $2,000,000 for the high-level subways. It stated that over 84 per cent of business houses in the affected streets favor the high-level subway and that while these companies realize that cut-and-cover construction will interfere with street traffic, they hold that the streets must be repaved and that it all should be done at one time. Private utilities are reported to be prepared to reconstruct their facilities on a "non-prejudice" basis without delaying for a court determination of their liability.

None of these claims and objections was presented when the board of engineers appointed by the PWA considered the original city project and recommended change to deeper subways. As reported at the time the essential reasons for the change were the hazard and difficulty of shallow subways, and the extensive disruption of business which they would cause; the vital necessity for providing transfer between opposite station platforms by means of mezzanines in order to facilitate traffic and avoid crossing the streets on the surface, and the superior speed, safety and economy of tunneling in the firm clay stratum found some distance below the surface. —EDITOR

Mass Transportation

Sir: Mr. Alfred Brahdy's letter in the May 25 issue, p. 699, fails to give any consideration to the merits of two-deck elevated highways as an engineering device which substantially solves the urban transportation problems of today and of the near future.

A two-deck elevated highway is a far different thing than a one-deck elevated highway if the upper deck is used by autos and the lower deck by busses to provide mass transportation. Such a structure, in a parkway or narrow street, will carry inbound traffic and its construction cost will be under one million dollars per mile. To carry outbound traffic, a similar structure on a nearby parallel parkway or street is needed. The construction cost is about $250,000 per lane per mile whereas the construction cost of a subway is about $2,500,000 per track.

Urban transportation must break away from its horse-and-buggy, subway and street-surface-speedway upbringing. Semi-depressed highways cannot properly connect to, get into or go through business centers and are much more costly. The two-deck elevated highway in streets, alleys and/or parkways is the answer.

RALPH R. LEFFLER
Chicago, Ill.

Water Softening

Sir: In the issue of March 30, p. 433, appeared an article entitled "Soap and Water Softening" which was an abstract of the paper that I presented at the South Dakota Water and Sewerage Conference. There is a bad typographical error in the sixth line from the bottom of the first column. The statement "soap costs from 100 to 3,000 times what it costs to remove it with lime and soda" should have been "soap costs from 100 to 300 times . . . etc."

At this late date I do not suppose there is anything that can be done about this error, but I want to be on record as not having made the statement in that form.

CHARLES H. SPAULDING
Supervising Chemist
Dept. of Water, Light & Power
Springfield, Ill.

About Professor Hoffman

Sir: Professor Ing. Oscar Hoffman of Milan University, whose book *Statica Delle Dighe* was reviewed by Mr. Floris in the Engineering News-Record of May 25, is now a guest lecturer in the subject of soil mechanics at Fenn College. He has several other books to his credit.

He has been connected with the Technical University of Milan since 1932 in the capacities of Professor of Hydraulic Structures for the graduate school, Professor of Cement and Concrete, Professor of Materials and Vice-Director of the Materials Testing Laboratory of the Royal Technical University sections of Materials of Construction and Soil Mechanics.

Professor Hoffman established the first soil mechanics laboratory in Italy and is one of the leaders in the study of this field in Europe.

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LITTLE ENTHUSIASM has greeted the President's proposal of new large-scale construction through so-called self-liquidating loan. Nor are the items of the proposal adapted to inspire enthusiasm, even in the construction industry. They represent more spending and unsound spending. The whole proposal, smacking of hasty improvisation, offers little chance of being helpful to cities, to industry, or to taxpayers. The construction industry itself might lose more in reduced private construction, scared by federal guarantee of unsound loans, than it could gain through monetary stimulation by increased public works.

Cooperation Pays

PRESIDENT DELBRIDGE in his valedictory address to the American Society for Testing Materials last week paid graceful tribute to cooperation between technical societies and industry. The petroleum industry, he said, has received more from the society he was addressing than the society has received from it. This voluntary acknowledgment is timely, for technical cooperation does not always receive the credit it deserves. Other industries have benefited from society action as much as the oil industry, we feel sure. And even though each company in an industry, as well as the industry as a whole, assiduously carries on research for product improvement and more efficient manufacture and use, there are further gains to be derived from the broader technical cooperation provided through technical societies. Such cooperation permits all to share in the advance made by each, and accelerates progress by pooling ideas and objectives, raising the level of minimum acceptability, and bringing science and technology into closer contact. When such possibilities of cooperation once are fully appreciated by all, and men of the right temper of mind are enlisted in the work, maximum progress of both industry and technical societies is assured.

Lack of Imagination

A LOT OF GOOD SENSE is packed into Fred N. Severud's article on avoiding cracks in building walls which is applicable beyond the subject under discussion. Cracks, Mr. Severud says, are the result of lack of imagination on the part of the designing engineer. Many other defects in our structures find their origin in the same lack—on the part of architects as well as engineers. Imagination may be said to be the characteristic that distinguishes the true architect or engineer from the routine technician, who designs a building, a bridge or a dam according to the rules laid down in books and does not visualize how the elements will function as parts of the whole structure. Skill, imagination and ingenuity must go hand in hand if structures are to be free from defects and a credit to their designers.

Manufacturing Foundations

INVENTIVENESS in devising repetitive operations is a striking development in modern construction methods. It is rapidly placing engineering field work in line with the processes of the factory, where duplication of operations has led to the astonishing economies of production of everything from paper clips to motor trucks. One of the earlier examples is paving with concrete, where mile after mile almost the same movements of men and machines are repeated for days and weeks. A later example is the building of bridge foundations, where piers and footings mount into scores, as the case of the Storstrom Bridge described on a following page. Ingenious as are the floating cofferdams and the launching of the shore-built pier shells devised by the Danish contractors, the real invention in engineering economics is the repeated use of four cofferdams to construct two-score of foundations. The lesson is important at a time when in this country increasing road traffic is demanding long crossings of the bays and tidal inlets that line the Atlantic coast.

Effective Disposal

AS A PRACTICAL METHOD, the San Francisco disposal of city refuse by fill-and-cover procedure has proved to be satisfactory and excellent. The wide applicability of the method justifies the space given

in this issue to a record of practice at the Golden Gate. World-wide experience moreover confirms the efficacy of disposal by fill. But refuse problems in addition to their practical or technical side often acquire psychological aspects, as in the comic-opera dispute that has raged in New York for months, where indictments were found against public sanitation officials who were doing their best to serve the public efficiently and economically. Fortunately, at San Francisco these psychological aspects vanish, as the fill area is beyond the limits of the city, and the collection and transport of refuse is unavoidable in any event. There are many unsolved scientific problems in connection with refuse-fill disposal, and these are now under study in New York. It may be desirable to give equally careful study to the psychological factors.

When Materials Yield

ALL OF US have been taught to believe that a beam or column is safe only as long as its load remains within the range of perfectly elastic action. Likewise we hold it axiomatic that levers, shafts and gears in machines become unsafe when any small part or particle begins to yield. Common observation ought to tell us that something is wrong with these beliefs, for we rightly distrust those materials that approach nearest to fully elastic behavior—the brittle materials—and instead choose tough materials, those that are able to yield. Yet the classic concept of perfect elasticity is so deeply rooted in our habits of thought that the Marburg lecture at last week's A.S.T.M. convention was appropriately devoted to revealing its fallacy.

Prof. H. F. Moore, the lecturer, first jolted the designing engineers in his audience by asserting that but for relief of stress by localized inelastic action "it would be very doubtful whether our structural and machine parts would stand up in service"; the ability to yield, in other words, is the saving virtue of constructional materials. At once, however, he made the case convincingly clear by saying that plaster of Paris, though almost perfectly elastic, would never be used for a crane hook even if we had plaster of very great strength. Nor, he might have added, would we use glass for a derrick boom or a locomotive axle.

Conscious recognition of the essential value of yield and adjustment in structural materials can undoubtedly help the designer's thinking greatly. It would aid in understanding, for example, why riveted joints are much stronger than stress measurement or computation indicates, and under what conditions the added strength can no longer be relied on. It would eliminate many fears about secondary stresses. It would save pages of calculation wasted on composite action in dams and rigid frames.

In discarding traditional acceptance of perfectly elastic action we must not, however, go to an extreme. In the case of steel structures, for instance, we could easily be misled. Refined measurements, which tend to show that "elastic limit" approaches zero as more and more sensitive instruments are used, might lead us to conclude that every structure is gradually failing. But common sense will lead us to consider the 50 years of the Eiffel Tower, reached a week or two ago, or the nearly 60 years of the Brooklyn Bridge, which are living refutation of any such fear of progressive failure.

Plastic deformation carries no menace to the safety of structures, which as a practical fact are perfectly elastic. But while the concept of elastic action up to a more or less definite limiting load remains true in the broad sense, in detail it needs to be supplemented by a clear appreciation of inelastic effects. This essential addition to our standard design principles affects safety and economy alike.

On the Griddle

WHAT PRACTICES in the construction industry are slowing up progress and increasing costs? The Attorney General hopes to answer this question through widespread action against practices that can be attacked in restraint of trade. Prelimnary to this legal action, the monopoly committee has begun hearings in Washington to ferret out causes of high construction costs.

Some of the practices that the Attorney General considers worth investigation were outlined recently before the New York Building Congress by one of his assistants, Thurman Arnold, as given elsewhere in this issue. By attacking these practices on a wide front the department hopes to produce an effect that cannot be affected by scattered prosecutions.

Anyone familar with the construction industry knows that there are practices that increase costs, but those that are of national importance are few in number. It would seem that more good could be accomplished quickly by a concerted attack on those practices than by putting the whole construction industry on a hot griddle.

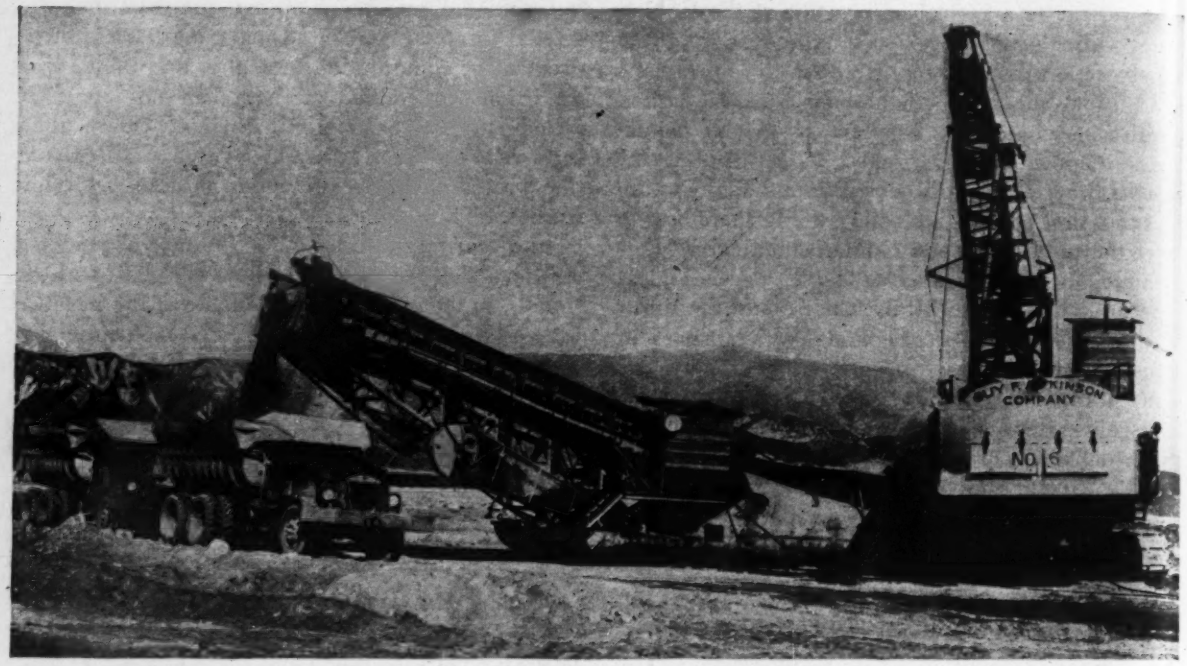

FIG. I. DRAGLINE AND DRAGVEYOR LOAD TRUCKS IN FAST TIME AT HANSEN DAM.

New Earth-Moving Equipment at Hansen Dam

Contents in Brief *— Two new types of earth-moving equipment are being used for the first time on large scale operations at Hansen Dam near Los Angeles. One is the Dragveyor, a belt conveyor loader used as a material transfer between dragline and trucks. The other is the Tournapull, a two-wheel tractor that hauls carrying scrapers at high speeds after they are loaded by aid of pusher tractors of conventional design.*

FACED WITH THE JOB of placing more than 13,000,000 cu.yd. of dry fill in Hansen Dam near Los Angeles, the Guy F. Atkinson Company of San Francisco, sought earth-moving equipment of greater capacity than conventional units. As a result, two new types of earthmovers are in use for the first time on large-scale operations, and both are turning out satisfactory daily yardages. The dam, 122 ft. high and 9,050 ft. long, contains five classes of materials placed in six zones, as described in *ENR* June 22, 1939, p. 846. The new earth-moving equipment fits in well with zone operation requirements.

Differing widely in purpose and use, the new units are designed to eliminate two shortcomings in conventional earth-moving equipment: (1) delays in truck loading time and (2) slow haul of carrying scrapers between borrowpit and fill. To overcome the truck loading delay, a Gar-Bro Dragveyor has been installed, consisting of a belt conveyor loader charged by a dragline handling a slackline cableway bucket. To speed up movement of scrapers, they are hauled by Tournapulls, two-wheeled tractors capable of 20-m.p.h. speeds.

Dragveyor operations

The Gar-Bro Dragveyor, built under Hollerbach patents by Garlinghouse Bros., Los Angeles, consists of a curved bottom steel hull carrying an inclined belt-conveyor frame cantilevered out from one end (Fig. 1). One-half of the 59-ft. length of the hull is shaped as a hopper with a 14-ft. mouth and sloping lips; the other half is cut away at the sides to mount the cantilevered conveyor frame and the conveyor motor. A 60-in. belt conveyor, 79 ft. long and powered by a 75-hp. slip ring electric motor, passes through the hopper and up the inclined frame to give a clear dumping height of 20 ft. at the outer end.

The Dragveyor is placed transverse to and directly in front of a Bucyrus-Erie 100-B electric dragline (Fig. 2). Attached to the dragline frame by two chains, the loader is dragged along as the excavator moves backward away from the pit. On this installation the 3-yd. dragline bucket usually used with the 100-B dragline has been replaced by an 8-yd. Sauerman Crescent slackline cableway bucket and the dragline boom has been lengthened to 90 ft. Working on the top level, the dragline excavates a pit 18 ft. deep over a bottom width of 70 ft.

Equipped with the bottomless

bucket, the dragline works on the principle of a slackline cableway. Material is not lifted but is hauled up the pit slope and dumped into the Dragveyor hopper where it falls onto the belt through a heavy grizzly that keeps out the boulders. While the loader in no way interferes with the swing of the dragline, it does foul the fairlead line in normal position. Therefore, special fairleads have been installed high on the boom mast so the pull line clears the loading hopper.

Loading of trucks is controlled by an operator standing on a platform at the outer end of the belt. As the hopper has considerable storage capacity, excavation and loading operations need not be synchronized. The belt, which travels at a maximum speed of 250 ft. per min., is controlled through a street-car type control. It is stopped when a truck is not in position to receive the discharge. A suspended marker aids the drivers in spotting the trucks, and colored light signals, flashed by the belt operator, tell the driver when to move ahead a little to distribute the load and when his truck is loaded. This end of the operation is similar to that of elevating grader loading.

Atkinson is using ten 16-yd. Boulder Dam type dump trucks on the dragline operations. Though the trucks can be loaded in 75 sec., spotting time reduces the output to an average of 34 trucks or 550 cu-yd. per hr., loose measurement, or about 12,000 cu.yd. per day of three 7½-hr. shifts. As a 3-yd. dragline is rated about 275 cu.yd. per hr., use of the Dragveyor, even when operating at only 50 per cent continuous loading, about doubles the output of the dragline.

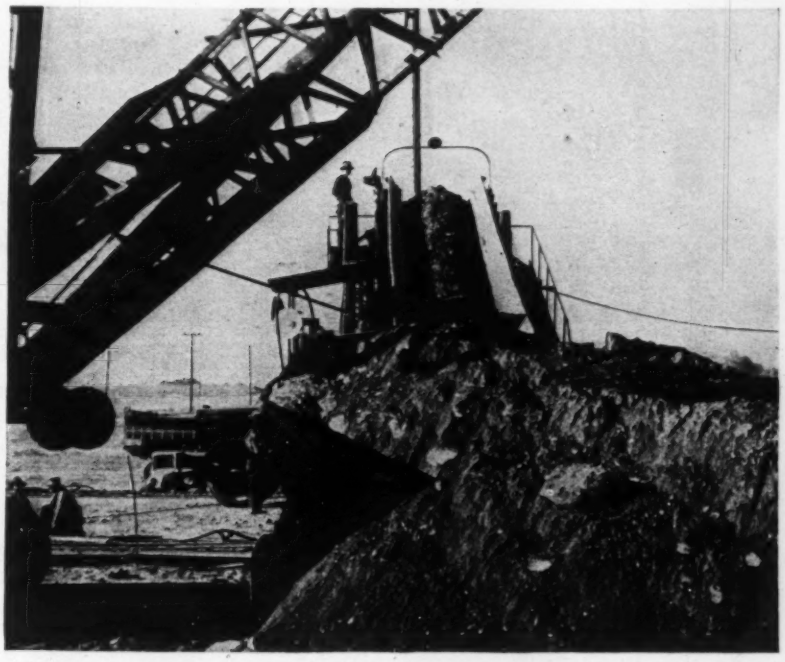

Fig. 2. The Dragveyor receives material from a slackline cableway bucket; discharges it into waiting trucks. The loader is pulled along by the dragline backing away from the cut.

Power for both dragline and loader is supplied through a portable transformer mounted on skids and kept close to the machines.

Tournapull scraper haulage

Equally interesting, but radically different in character, are the carrying scraper earth-moving operations. Here 25-yd. LeTourneau scrapers are

Fig. 3. A slip-scrapers unit in the borrowpit. The 25-yd. scraper and tractor unit in the center is being pushed and pulled by crawling tractors. The latter are required for loading only.

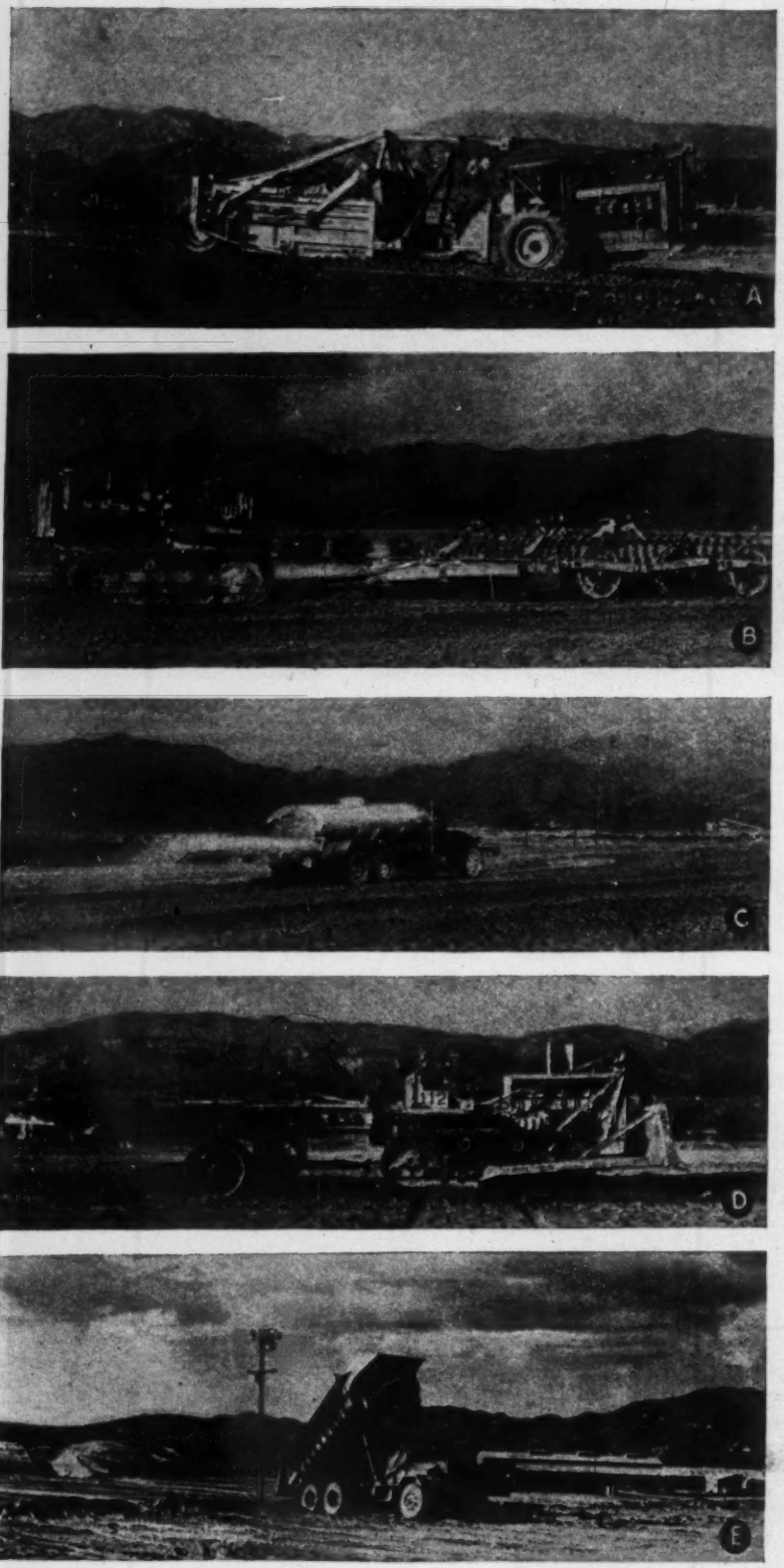

Fig. 4. Activities on the fill. *A*—Scraper unit dumps and spreads a 25-yd. load; *B*—Triple tandem sheepsfoot rollers compact the new layer to desired density (note the grader blade in front of first roller that levels up the rough spots); *C*—Water is added between rollings to obtain the optimum moisture content; *D*—Roughening with a scarifier provides a good bond for the next layer; *E*—A 16-yd. load goes into the downstream section where layer-placement and rolling are not required.

being hauled by the new Tournapull tractors, also made by LeTourneau. The fleet contains eleven Tournapull-scraper units and seven Caterpillar crawler tractors used as pushers to assist in loading. Two more Tournapulls and scrapers are kept as spares.

The Tournapull is a two-wheeled 30-ton tractor mounted on 24x32-in. pneumatic tires (80 in. high) powered by a 160-hp. V-8 diesel engine. The engine is carried on a frame extending in front of the axle, balanced by the weight of the scraper hitched behind. While the tractors are rated at 20 m.p.h. maximum speed under full load, such speed is seldom, if ever, reached on this job.

The scraper units are assigned to the impervious center section of the dam. Material for this section lies in thin strata of various clay and clay-sand formations, some of which are rather hard. On the whole, the impervious material borrowpits are tough digging for scrapers, loading requiring the full power of the pulling tractor and two crawler-tractor helpers.

All of the helper tractors are fitted with bulldozers equipped with pushing blocks, and three of them also carry a pulling hook which connects with a pulling eye on the front of the wheeled tractors. Under usual borrow-pit conditions both a pusher and puller tractor are needed to get a full load (Fig. 3).

Time schedule

Observations of one day's scraper operations showed the following time cycles: On this particular day the average haul was 2,300 ft., or a roundtrip distance of 4,600 ft. The average time for a complete round trip was 10.4 min., divided into loading, 2.7 min.; load haul, 4.8 min.; dumping, 0.7 min.; return trip, 1.6 min.; lost time at pit, 0.6 min. Thus, the tractors averaged 5.44 m.p.h. on the load haul and 12.5 m.p.h. on the return trip. These time figures were obtained by observing one particular scraper unit only. In each 25-yd. load of loose earth there is an average of 17 cu. yd. of pay dirt.

On the day the above time cycle was clocked the haul happened to be unusually short, only 2,300 ft. Actually, the haul on the west side ranges from 2,500 ft. to 5,000 ft.; on the east side it varies from 4,000 ft. to 9,000 ft.; the job average is about 1 mile. Furthermore, these observa-

tions were made early last spring, when the borrow pits were shallow and the fill was low. As the fill progresses and the pits go deeper, both the length and height of haul increase with resulting decrease in daily production. During March and April, the best months to date, the scraper fleet averaged 21,600 cu.yd. of pay dirt per day, which figure is decreasing.

Tractors and scrapers are serviced by a special truck carrying lubricating oil, power grease guns and a diesel-driven compressor furnishing air for the tires and grease guns. Fuel oil is supplied by another truck. Both trucks go right into the borrow pits to reduce the time of service delays to a minimum.

Hansen Dam is part of the Los Angeles County flood control project being carried out by the U. S. Engineers under the direction of Major Theodore S. Wyman, Jr., district engineer. A. H. Steiner is resident engineer in charge of construction of the dam. For the contractor, the Guy F. Atkinson Co. of San Francisco, Geo. H. Atkinson is job manager and A. E. Holt is superintendent.

Avoiding Cracks in Building Walls

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***Contents in Brief**—An epidemic of cracks in the brick bearing walls of a large number of the completed public housing projects has focused attention on this recurrent problem. The crack forming phenomenon is explained as a function of concrete floor slab shrinkage. Recognition of the interplay of stresses in the different materials used to form a single structural unit is basic to crack control. Horizontal concrete bands around each story and vertical concrete struts at corners and between windows are effective.*

JUSTIFICATION for the common statement that "A certain amount of cracking is unavoidable in any kind of structure" would seem to be strengthened by the experience on the completed public housing projects which, with only a few exceptions, developed serious cracks in the brickwork, particularly in the parapet walls. However, many structural engineers, the writer among them, deny that cracks are unavoidable and, on Harlem River Houses, one of the public projects in New York City, the structural design for which was executed by the writer's office, there is no cracking problem.

It is probable that cracks often result from a lack of structural imagination on the part of the designing engineer. What, for example, is the situation at the parapet wall where most of the housing trouble was experienced? Referring to Fig. 1, a plan of the end bay of a typical housing unit, it may be noted that the major shrinkage forces occur in the long direction of the building. Walls *A* and *B* restrain the action of these forces in direct compression. Wall *C*, however, being relatively very flexible, is distorted by these forces; its position after shrinkage of the concrete slab is shown by the dotted lines. The shrinkage pulls this wall taut as the string of a bow.

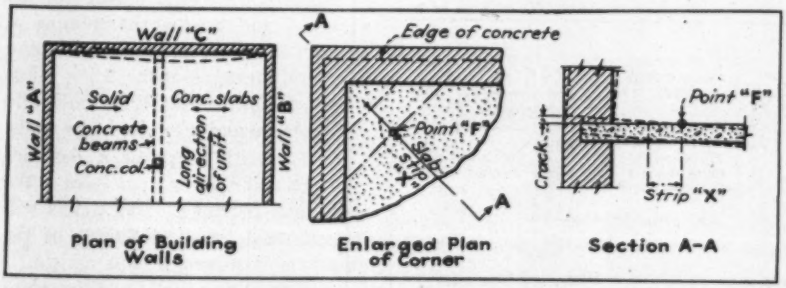

Fig. 1. **Plan and details of concrete floor and brick bearing-wall building illustrating formation of wall cracks at the corners of buildings by shrinkage of slab concrete. Rigidity of corner strip "X" forms a fulcrum over which deflection forces in floor slab exert a prying action on walls.**

Next consider the condition existing at the outside corners of the unit, also shown in Fig. 1. The imaginary slab strip "X" forms a very rigid beam, with a span so small that it has practically no deflection. The roof slab as a whole, however, will deflect, and the deflection will be augmented by the fact that in the middle of the span the slab has bottom reinforcement only. Thus the concrete in the top is free to shrink while that in the bottom is restrained by being bonded to the reinforcement, which absorbs a portion of the shrinkage forces in compression. Relatively, then, the top fibers are shorter after shrinkage than the bottom fibers. These deformations correspond to the action of dead and live loads and add to the total deflection. From Section AA in Fig. 1, it is obvious that the stiffness of slab strip "X" provides a fulcrum for these shrinkage and deflection forces, with the result that a corner of the wall is pried loose. As the corners are lifted off their bases, the bond between concrete and brickwork is destroyed. The shrinkage forces are suddenly released, resulting in violent shattering of the corners. The corners actually "pop."

Measures to meet this situation are determined by the individual conditions. On the Harlem River Houses, for example, a continuous reinforced concrete band, integral with the concrete roof slab, is used entirely around the buildings. This detail is shown in Fig. 2, together with others used by the writer on various jobs where

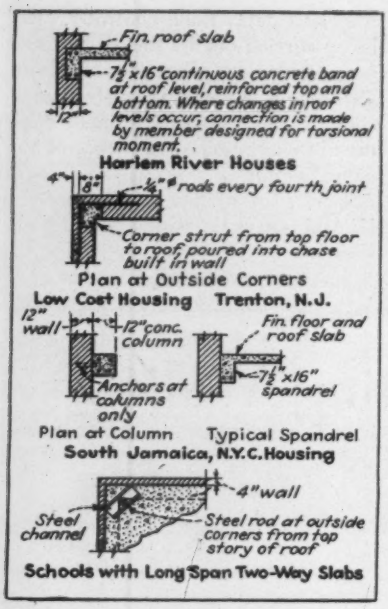
Fin. roof slab
7½"x16" continuous concrete band at roof level, reinforced top and bottom. Where changes in roof levels occur, connection is made by member designed for torsional moment.
Harlem River Houses
¼" ø rods every fourth joint
Corner strut from top floor to roof, poured into chase built in wall
Plan at Outside Corners
Low Cost Housing Trenton, N.J.
12" wall
12" conc. column
Anchors at columns only
Fin. floor and roof slab
7½"x16" spandrel
Plan at Column
Typical Spandrel
South Jamaica, N.Y.C. Housing
4" wall
Steel channel
Steel rod at outside corners from top story of roof
Schools with Long Span Two-Way Slabs

Fig. 2. Typical expedients used to avoid cracks in brick-bearing-wall buildings with concrete floors.

avoidance of wall cracking was a major consideration.

To take another example, in a large federal penitentiary recently built to the writer's design, the essential features are as shown in Fig. 3. There were three different materials to coordinate: Concrete frame; an 8-in. brick wall; and a 4-in. concrete block wall. Wall struts *W* and corner struts *C* grip the brickwork firmly and tie it to the concrete frame, so that there is no opportunity for a separation of the two materials. The struts are formed by leaving chases in the brickwork. Since there is a tendency for cracks to form at the wall struts, ¼-in. round reinforcing bars are laid in every fourth joint of the brickwork. The concrete blocks are laid up on the inside of the chase, with metal anchors into the chase at each block joint. Concrete is then poured into the chase, forming a strut.

The concrete blocks are tied to the concrete frame only. No anchors penetrate the insulation or the cement parging, so that there is no opportunity for water to follow metal anchors and produce leaks.

The wall bands *B* are continuous in the whole perimeter of the building at each floor and roof level, except at the first floor. The bands are kept at the window heads and form lintels over the windows. Where the levels change, continuity is provided by vertical sections that are proportioned to resist the moments and shears produced. The absolute continuity of these bands must be accomplished, otherwise trouble will start at the free ends and be of a serious nature since the deformation differences are accumulated at these points.

While this construction is of a special nature, certain features of it may be logical to solve individual problems. The corner struts, for instance, are very effective in preventing the "curling up" of the slab corners. The wall bands are always advantageous where they can be accommodated. However, each building has its own problems, and it is the failure to appreciate this fact and to use stereotype designs that is the greatest contributing factor to cracking in building walls.

If one were to attempt to select a single cause for faulty design the almost universal disregard of the interplay of stresses in different materials used to form one structural unit would take high rank. Steel relieving beams, for example, are often used over a stone lintel. A common method of design is to proportion the beam according to a safe working stress for the steel. But the elastic deformation of the stone is comparatively much less than that of the steel so that the stone lintel carries the major part of the load. Not being proportioned for such a load, it eventually gives up and suddenly transfers the load to the steel beam. The result is a cracked stone lintel.

A correct design for this lintel would be to: (a) Assume a safe tension stress in the stone; (b) compute the corresponding deflection; and (c) select a steel member that will not exceed this deflection under load.

An analagous situation occurred at the main entrance of a monumental building. The entrance was formed by a large masonry arch which, although not designed for it, supported a part of a tower. A steel girder, designed with a working stress of 16,000 lb. per sq.in. had been placed above the arch to take the tower load, but because, compared to the masonry arch, it was comparatively flexible, it acted at first, merely as a dead piece of steel; the small deflection resulting in the arch when the load was applied corresponded to only a trifling stress in the steel beam. However, since the arch abutments had not been proportioned for the load, they eventually failed and threw the whole load on the steel girder. Huge stones were forced out of position and turned as much as 2 in. out of their bed. Fortunately the steel girder held when the load came on it.

Another condition where the same principle holds is where comparatively narrow brick bands are supported on steel spandrel beams, such as parapet walls carried over long windows. It is the writer's experience that the fallacy of assigning the full working stress to spandrels under these conditions has not been recognized. And what has been the result? Due to the relative flexibility of the spandrel, the brickwork attempts at first to carry the load. It fails, and a general cracking of the brick joints ensues, followed usually by unsightly efflorescence and often by leaky walls.

The searching eye of a designer who is trained in the principles of the individual behavior of materials will immediately detect violations of the principles outlined in this article. If he removes the violations in plans that he checks and avoids them on his own plans the result will be construction that is free from structural defects and a credit to the designer.

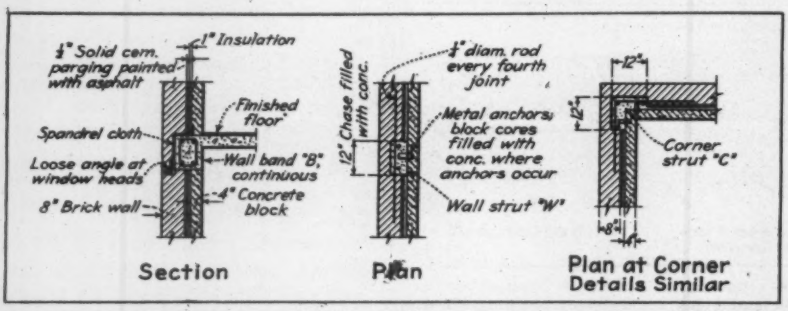

Fig. 3. To eliminate cracking tendencies of brick walls, continuous concrete wall bonds at the window heads of each story and vertical concrete struts at intervals along the walls and at the corners have been used successfully.

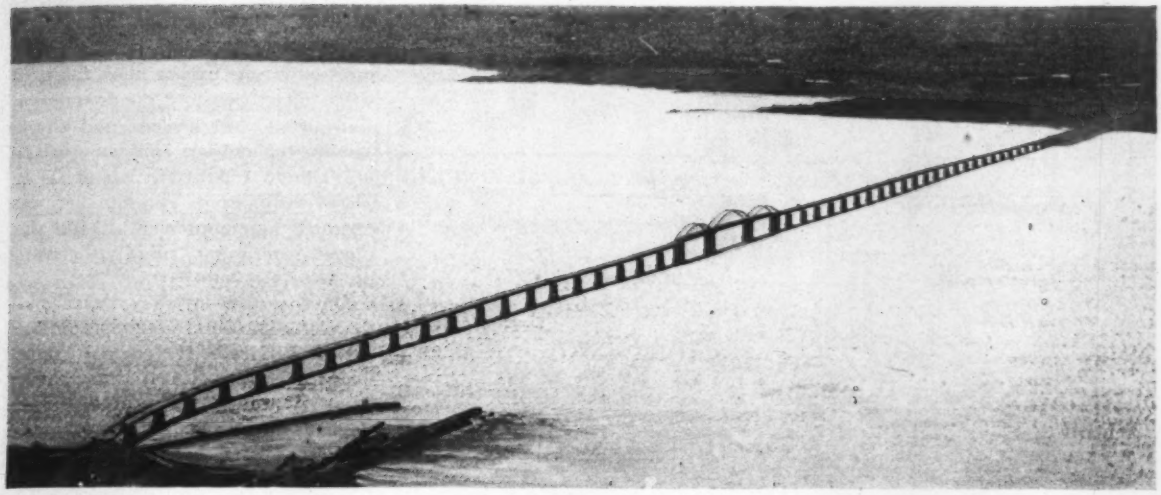

FIG. I. DENMARK'S STORSTROM BRIDGE OF FIFTY SPANS AND A LENGTH OF NEARLY TWO MILES.

Four Cofferdams for Forty-One Foundations

S. M. KOEFOED

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***Contents in Brief**—Repetitive use of floating cofferdams for Storstrom bridge in Denmark; structure of coffers and methods of using them described; 20-ft. high sections of stone-faced concrete pier shafts built on shore and floated to place on pier bases.*

A FLOATING-COFFERDAM METHOD that offers possibilities of wider use was employed in building the foundations of the Storstrom bridge in Denmark. Of the 50 piers of this bridge, 41 were founded by means of floating cofferdams that were moved from pier to pier. Two pairs of the floating coffers served all 41 foundations and when operations were fully organized a cofferdam was sunk, the foundation was built and the cofferdam was floated again in about 20 days. With the foundations completed another and more unusual floating operation was carried out. The 8-in. granite facing for the pier shafts from 10 ft. below to 10 ft. above water was laid up on shore shipways bonded to a hollow shell of reinforced concrete which was launched between two barges, floated to the pier site and sunk onto the pier base previously built in cofferdam.

Different bottom conditions indicated two forms of floating cofferdam. At the site of the bridge the bottom is about 100 ft. of glacial clay rich in lime and overlying chalk. The maximum depth of water is about 45 ft., shallowing to each shore. The plan was to excavate about 10 ft. deep within a ring of steel sheet piling, concrete the footing to the full size of the ring and build on it the pier base to 10 ft. below water level. This construction is indicated by Fig. 3 and it alone was the task of the floating cofferdams.

At the pier sites where the clay bottom was homogeneous and watertight, the cofferdam shown by Fig. 3 was used; the sheet pile ring was driven around the outer perimeter, the coffer was pumped out and the pier footing and base were concreted in the dry. Two cofferdams of this form built the foundations for 27 piers. At pier sites where strata of sand interlarded the clay and where hydrostatic pressure from beneath threatened bottom blow-ups, the cofferdam shown by Fig. 2 was used. In this form the sheet pile ring was driven around the inside perimeter of the coffer, the footing concrete was placed under water and when the bottom was sealed the coffer was pumped out and the pier base was concreted in the dry. Two coffers of this form were used for 14 pier foundations.

Both forms of coffers were ellipses in plan with two concentric steel

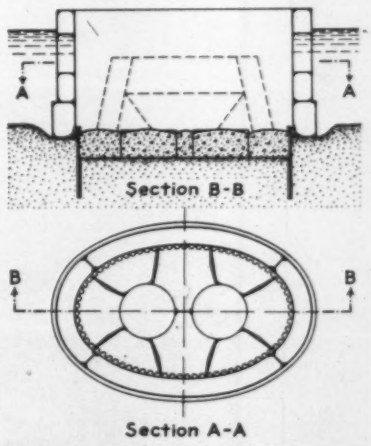

Fig. 2. Cofferdam for piers where ground conditions made construction under water necessary to prevent blow up of the bottom.

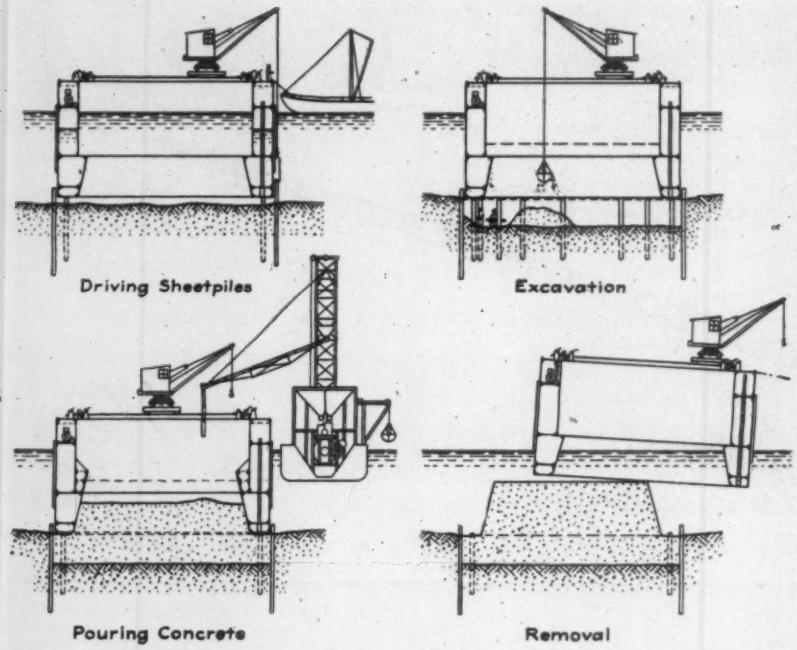

Fig. 3. Sequence of operations with floating cofferdam; two of these cofferdams built 27 pier foundations for the Storstrom bridge.

shells divided by watertight bulkheads and decks into a number of tanks that could be filled or emptied to sink or float the coffer. Also, each coffer had its own electric power plant to operate the pumps, the derricks and for lighting. Prior to a coffer being floated out for constructing a new pier, a ring of 16 timber piles was driven and the piles cut off level just above sea bed to provide a seat for the coffer when it was sunk to rest on its pile supports.

Of the 50 pier foundations 41 were built with the floating cofferdams; the remaining nine, including those for the channel spans (Fig. 1) were constructed in fixed cofferdams.

How the coffers were used

The method of handling both forms of floating coffers was the same and is clearly indicated by Fig. 3. Details of operations are made plainer by considering the two forms separately.

Fig. 4. Cofferdam of the type of Fig. 2 in place and ready for the excavating and concreting plant to begin work.

Form for External Sheeting—When the coffer had been sunk to position on the timber piles, the steel sheet piles to enclose the foundation slab were interlocked and hung around the outside skin and driven until their tops were about 2 ft. above sea bottom. The hammer was operated by compressed air and was moved from pile to pile by the crane on the cofferdam.

On the exterior circumference of the cofferdam close to the bottom was a bulge-shaped projection against which the sheet piles took bearing when the water level inside was lowered by pumping. The sheet piles prior to being hung had at their upper ends timber blocks fitted in the trough-shaped sections facing the cofferdam so that when the piles were driven the blocks came in contact with, or very near to, the bulge-shaped projection. The annular space between the blocks and the bulge-shaped projection was then made watertight by divers who inserted a heavy rope impregnated with tallow; pumping out of the water caused the rope to be sucked in tight and close the gap.

The excavation was by hand or by grab in the dry, and the concrete was deposited in the dry from a floating mixing plant, anchored alongside the cofferdam.

To remove the cofferdam, water was let into the space enclosed by it; then, by using jacks built into the cofferdam and bearing on the concrete base, it was given a slight movement in vertical direction, thus breaking the bond between the concrete and the lower portion of the internal skin. As a matter of fact a cofferdam usually lifted quite easily when the water in its compartments was pumped out without jumping up with too great a jerk. The removal then took place as shown by Fig. 3.

Form for Internal Sheeting—For the cofferdam shown by Fig. 2 all operations were as shown by Fig. 3 except the excavation and concreting, both were done under water. To control concrete placement it was found necessary to subdivide the volume to be occupied by the foundation slab into ten compartments by vertical shutters lowered through the water and fixed in position by divers (Fig. 2). The individual compartments had a superficial area of about 40 sq.yd. and with the tremie tube lowered in the center of the compartment, the concrete had at the most about 10 ft.

to spread out laterally. The output of the mixing plant being 25-30 cu.yd. per hour, the surface of the concrete placed in a compartment rose at the rate of 1½ ft. per hour.

After concrete had been placed in all ten compartments, the V-shaped space between the tops of the sheet piles and the inside sloping skin was filled with concrete under water and thus sealed.

Pier shaft construction

Above the base built inside the cofferdam the piers are hollow and construction methods were normal except for 20 ft. just above the base. This part from 10 ft. below to 10 ft. above water level was specified to be faced with granite averaging 8 in. thick in courses of 8 in. This part of the pier (Fig. 5) was built hollow on a slipway on shore down which it was slid and picked up by a series of lifting screws suspended from overhead girders spanning between two specially rigged barges, Fig. 6. It was then floated out and lowered upon the pier base, which had been surmounted by a beading of asphalt on which the lower bearing edge came to rest. Two pins projecting below engaged with two funnel-shaped holes left in the top of the base beneath and assured correct placing. The remaining pier concreting was carried out as shown by Fig. 7.

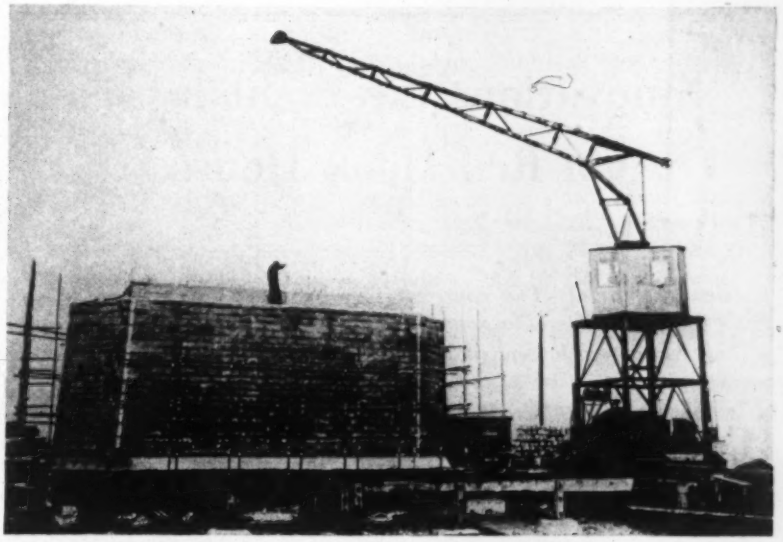

Fig. 5. Hollow pier shaft sections 20 ft. high built on slipways were launched and floated to the pier sites to be sunk on the foundations built in cofferdams.

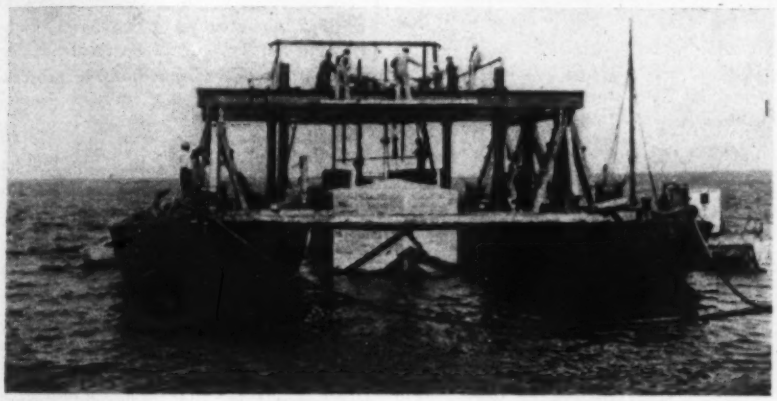

Fig. 6. Precast pier section being carried to place suspended between barges.

The total length of the bridge is 10,500 ft. There are 50 spans in all, of which forty-seven have lengths of about 200 ft. each, while the three navigation spans near the center of the bridge are respectively 350 ft., 450 ft. and 350 ft. long. The 200-ft. spans are designed as plate girders, 13 ft. high and continuous over the piers, with hinges arranged in every second span. The navigation spans are bowstring girders, their lower chord member consisting of heavy plate girders, acting as stiffening trusses. The clear height under the navigation spans is about 85 ft. Provision is made for one standard-gage railway track, an 18-ft. wide highway and a 10-ft. wide sidewalk.

Directing personnel

The bridge was built by the Danish State Railways under the supervision of its chief engineer, H. Flensborg, and the State Railways' consulting engineer, Prof. Anker Engelund. The whole of the substructure work was carried out by Christiani & Nielsen, Copenhagen, who were largely responsible for the design and who developed all the special working methods.

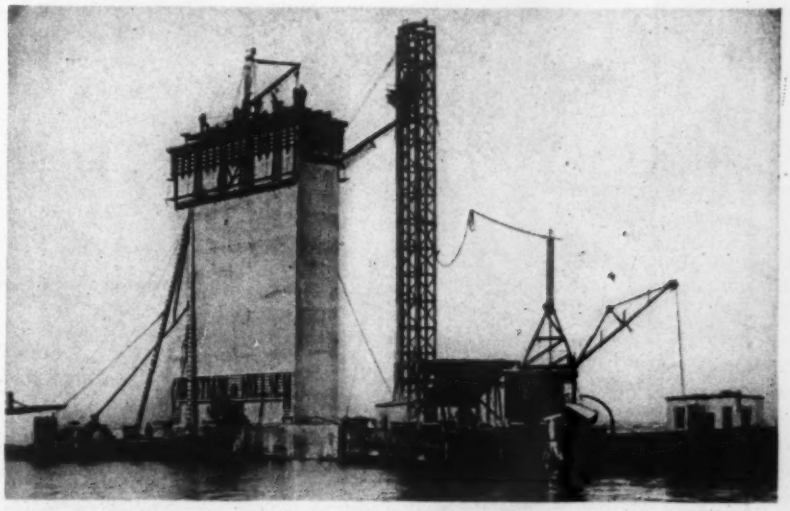

Fig. 7. Upper part of pier shaft being concreted in place using a floating tower and chuting plant.

Innovations Lower Slab Cost On Red Hook Houses

Contents in Brief—The contractor on Brooklyn's Red Hook Houses has effected considerable saving in floor and roof slab cost by the use of twisted bar reinforcement, which has 50 per cent higher permissible working stress, and by use of vacuumized concrete, which cures rapidly.

TWISTED-BAR reinforcement and vacuumized concrete have been used to advantage in lowering the cost of some 2,000,000 sq.ft. of floor and roof slabs, in the construction of Red Hook Houses, a $12,000,000 public housing project in Brooklyn, N. Y.

The project, when completed next fall, will consist of 25 six-story elevator buildings, containing 2,500 apartments and 10,500 rooms. All are fireproof, wall-bearing structures with reinforced concrete interior columns and girders and reinforced concrete one-way slabs. The buildings rest on uncased cast-in-place concrete piles, of which more than 9,000 were used on the job. Construction cost is about $850 per room, as compared with a cost of $1,400 per room for Brooklyn's Williamsburg Houses, built by PWA last year.

One-third saving in steel weight was effected by the use of Isteg high-strength twisted dual-bar steel reinforcing. This reinforcing consists of two rods twisted cold in a helix, for which the New York building code, adopted in 1937, allows working stresses 50 per cent greater than for ordinary bars of the same grade steel.

Vacuumized concrete

On concrete construction during cooler months, use of the vacuum concrete process to remove excess water from the slab, as a means of hastening surface finishing and strength development of the concrete, has produced savings for the contractor by reducing finishers' overtime and by assuring form stripping in a minimum of time. As a result of time saved through use of this process, it has been possible to use a single set of ⅝-in. Douglas fir plywood slab forms per building to maintain ample construction speed. Each set is used on three buildings, with replacements of plywood panels as needed. An additional saving was secured during the winter, when nearly 1,000,000 sq.ft. of slab was placed, because of fast strength development in the concrete, which greatly reduced heating costs.

Fig. 1. One vacuum mat has just done its job. Note dried surface.

Fig. 2. Cold-twisted twin-bar high strength reinforcing as installed in the slabs on the Red Hook housing project.

Concrete is dried out and compressed by the vacuum process immediately behind screeds which strike off the freshly placed material, enabling the finishers to work about 20 ft. behind the spreading and vibrating crew. During January and February, an average of 12,500 sq.ft. per day was laid, and this figure rose to 14,500 sq.ft. during March. The high record was 24,000 sq.ft. per day, allowing 1 hour overtime for finishers. During warm weather, however, the vacuum process is not used, for surface evaporation is fast enough to give suitable progress.

The vacuumizing equipment consists of a truck-mounted suction pump connected through hose and pipe manifold to a set of 3x4-ft. plywood mats fitted with fabric filters on the working faces. When these mats are left on the surface of a slab 2½ to 4 min., about one gallon of water is removed per sack of cement.

Vacuumizing equipment was fur-

nished to the George A. Fuller Co., general contractor, by the Vacuum Concrete Co., New York, N. Y. Isteg reinforcement is manufactured at the Buffalo plant of the Wickwire-Spencer Steel Co.

The project is being built by the New York City Housing Authority with funds provided by the U. S. Housing Authority. Alfred Rheinstein is director of the New York City Housing Authority, and design and construction is under the direction of Allan S. Harrison, secretary. John M. Johnson is construction manager on the project.

Chicago Filtration Plant Plans

Design features of the 225 mgd treatment works are based largely on results obtained from experimental plant

BASIC DATA on which the South District filtration project in Chicago is being designed were given recently to the Illinois Section, American Water Works Association, by Loran D. Gayton, city engineer, as follows: The undertaking is located on the lake shore just north of 79th St. and will cover an area of 150 acres back of a breakwater. A bulkhead or cofferdam incloses the 38-acre site of the filter plant proper and 115 acres of filled-in land forming a beach and park. Some 11,000 ft. of 16-ft. tunnel in rock will be required to make connection to the existing intake tunnel and to the existing tunnel of the distribution system. Contracts are under way for the breakwater and bulkhead. Bids have been received for the beach and park fill, also for the connecting tunnels.

Under the PWA grant of 45 per cent of the $12,000,000 program, which includes the above items plus installation of 50,000 meters, the work is scheduled to be completed by June 30, 1940.

The plant is being designed for an average delivery of 225 mgd and an hourly peak of 450 mgd. It will supply filtered water to three south side stations, the Roseland Pumping Station, the 68th St. Pumping Station and part of the supply to the Western Avenue Pumping Station.

Filtration rates

The capacity is based upon a maximum average daily filtration rate of 2.5 gal. per sq. ft. per minute in winter and 3 gal. in summer. These rates are based upon the use of acid-treated sodium silicate in the treatment of the water to strengthen the coagulation during periods when the coagulation produced by the use of a coagulant only would not be strong. These rates may be exceeded for periods of several hours daily with 3 gal. per sq. ft. per minute being a maximum winter rate and 4 gal. being a maximum summer rate. On account of the high friction loss through the sand beds at or above the 4-gal. rate, this rate should not be exceeded or attempted to be used continuously throughout the day. Should a coagulant only be used, the maximum winter rate should average not more than 2 gal. for the day and should not exceed 2.5 gal. at any time of the day.

The time of settling should be 4 hr. for the yearly average of water treated which will be reduced to 2 hr. at the peak rate. The settling basins as planned are to be two-story with 16-ft. depth of water in each story. The water will pass from the mixing basins through the settling basins to the opposite end, then under a curtain wall and up in a chamber where it may be recarbonated when lime is used in the treatment.

The filter beds are to be 54 ft. long and 26 ft. wide with a surface area of 1,390 sq. ft. The top of the washwater troughs are to be set 24 in. above the top of the sand or at an elevation so that no part of the trough will touch the sand when the filter is in service. The washwater gutter is to extend lengthwise of the filters so that the length of the washwater troughs is that of the width of the filter bed. The water level is to be maintained, under ordinary conditions, 7.5 to 8.5 ft. above the top of the sand. Perforated pipe underdrains, 4 in. in diameter on 12-in. centers, will be shown on the plans, but bids on patented filter bottoms will be received.

One third of each settling basin is to be equipped with continuous sludge removing devices of the scraper type. The remainder of the basin will be cleaned by dewatering and flushing out the sediment. Sludge removed by the continuous removal devices will be carried to a concentration basin where the nearly clear water overflowing the outlet of the basin will be returned either to the pump suction chamber or to the lake. Under some conditions a portion of this sludge may be returned to the raw water to aid in sedimentation.

Chemical treatment

Lake Michigan water is easily coagulated with any of the coagulants used in water treatment. The water contains an abundance of microscopic organisms which tend to clog the filters rapidly unless those micro-organisms are removed from the water before it reaches the filters. If a coagulant only is used, it would require a settling period of 12 to 16 hr. and a filtration rate not to exceed 2 gal. per sq. ft. per minute to obtain filter runs long enough for the practical operation of the plant. Experimental work has shown that with the use of lime partially to soften the water good removal of the micro-organisms may also be accomplished with 2 or 3 hr. sedimentation. The investigations indicate that it is economical to provide for the use of lime for this purpose rather than use slow rates of filtration and long periods of sedimentation. If this scheme is used it is indicated that rates of filtration in excess of the 2-gal. rate would give satisfactory clarification of the water 90 per cent of the time.

Further experiments have shown that a colloidal silicate produced by acid-treating sodium-silicate and adding this to the water will strengthen the coagulation. Using this treatment during periods when the coagulation does not form so well, faster rates of filtration may be used. The sodium-silicate treatment has proved so effective there is positive proof that both coarse sand and fast rates of filtration may be used without danger of coagulated matter passing through the filters.

Anti-Trust Study of Construction To Center on Housing Costs

***Contents in Brief**—Plans of the Attorney-General's department for a nation-wide investigation of combinations in restraint of trade that affect the cost of construction outlined. Study to be centered on mass housing. Practices which Attorney-General believes affect the cost of construction enumerated.*

THE FEDERAL GOVERNMENT'S efforts to free the nation of trade restraints that affect the cost of construction are to be centered on mass housing, according to Thurman Arnold, Assistant Attorney-General. Mr. Arnold made this announcement at a meeting of the New York Building Congress on June 21, at which time he gave the first details of the investigation of the construction industry that the Attorney-General announced some weeks ago would be made in the near future. Because of the importance of this study to the construction industry, extracts from Mr. Arnold's statement are given below.

The anti-trust laws are not designed to destroy the efficiency of mass production where the savings are passed on to the consumers. They are concerned only in those organizations which singly or in combination, fix prices or restrict production or eliminate industrial experimentation or new enterprise by arbitrary control over the free flow of goods in commerce. Today I am going to talk of the place of anti-trust enforcement in clearing the obstructions in the building industry.

In order to free the distribution of any product from restraints we must do more than attack individual concerns in a helter skelter fashion. We must investigate the process from beginning to end and attack simultaneously every combination which is blocking the distribution of a product from the raw material to the consumer. Within a single industrial field, to attack one of a series of combinations and leave others alone is simply to give an advantage to those who do not happen to be investigated. We must take such related combinations up all at once if we are to produce economically desirable results.

In building we have a series of restraints, protective tariffs, and aggressive combinations which has practically stopped progress. No one knows how a house ought to be built or what materials are the most economical or how they should be distributed. Because of the existence of aggressive combinations, experimentation in housing has to proceed by compromise with various gangs. Both standardized equipment and experiments with standardized methods of construction are limited in large scale housing projects largely because of these compromises.

I believe that we can develop the techniques to build cheaper houses. I believe that we have the enterprise to experiment with those techniques. I believe that the only instrument presently available for freeing the channels of trade so that such experiments can be conducted is the enforcement of the anti-trust laws. This requires taking up the production of housing as a single field of activity.

No major economic purpose can be attained by pursuing a labor union in Los Angeles, a group of contractors in Chicago, and a heavy industry in New York for anti-trust violations in the building field. Of course it is our duty to prosecute complaints, and isolated prosecutions may protect particular competitors from injury. But the economic results in housing can only be accomplished by prosecuting on a nation-wide scale, and simultaneously, the various combinations which are creating the log jam in the building industry.

The building industries are unique in that they have frankly given up half of their job. They take for granted that it is impossible, as things are today, for them to build houses without public aid and sell them cheaply enough that the lowest paid half of the population can afford to live in them. This has been true for four reasons: That financing costs were high, that taxes were high, that land was high, and that the costs of construction were high. Recently a broad federal and state program has undertaken to provide adequate cheap credit and even subsidies. But the easing of this difficulty has afforded an opportunity for costs of construction to go still higher.

During the latter half of 1936 and the beginning of 1937 students of housing believed that the long delayed revival of building was at last at hand. Building contracts rose month by month. But building costs rose at the same time and choked the revival. In a number of our large cities the rise of building costs was more than twenty-five per cent. In more than half the cities reporting it was over ten per cent. The collapse of construction followed and contributed much to the recession in 1937.

Unreasonable restraints of trade are, in my opinion, the most conspicuous reason for high construction costs. They appear at every level of the building industry. To give a picture of the problem, I shall list typical practices of the building industries which have been found in recent government proceedings of investigations or are involved in substantial complaints to the Anti-Trust Division.

Producers fix prices

Producers of building materials have fixed prices either by private arrangement or as the principal activity of trade associations. Owners of patents on building materials have used them to establish restrictive structures of price control, control of sales methods, and limits upon the quantities sold. By the use of basing

point systems, and zone price systems, various building materials industries have established by formula a rigid structure of uniform prices throughout the country; and in some of these industries such price formulas have encouraged the wasteful location of industrial plant and the wasteful shipment of products to great distances. The use of joint selling agencies has been another means by which some of these groups have undertaken to maintain their prices. In some groups the various producers have subscribed to the theory that every member of the industry should have a definite share of whatever business there is to be done, and that no concern should try to get more than its share by price competition.

Supplementing these various devices for keeping the prices of building material high have been a series of other devices used to discipline competitors who are unwilling to play ball. In one industry the means is cutting off the supply of raw materials. In another it is starting a series of harassing lawsuits. In a third it is the harassment of distributors by selling through the seller's own factory branches at prices lower than those at which the distributor is permitted to resell. In a fourth it is the maintenance of orthodox channels of distribution by concerted refusal to sell to groups representing new methods of sale or new price policies.

Restraints by distributors

Various groups of distributors of building materials engage in two kinds of restrictive practice. First, they try to raise the price of their services by establishing a fixed mark-up between the price they pay the manufacturer and the price at which they resell. For this purpose they collusively determine their mark-up or their selling price, and sometimes agree among themselves to boycott manufacturers who will not cut off supplies from price-cutting distributors. Sometimes they conspire with manufacturers' groups to establish a joint price control binding upon the manufacturers' and the distributors' organizations alike.

The second type of restraint by distributors arises from the effort to see to it that all business passes through their hands and that no new methods of distribution are introduced which may dispense with their services. The great weapon in this field is the boycott. Groups of wholesale distributors may boycott those who sell direct to retailers. Groups of retailers may boycott those who sell direct to mail order houses or direct to the ultimate consumers. Sometimes the members of a distributors' organization will boycott any manufacturer who sells in their territory to nonmembers. To secure freedom in methods of distribution, some manufacturers have found it necessary to pay the distributor a commission on sales even when the customer and the manufacturer have dealt direct and the distributor has had no part in the transaction.

Contractors' practices

Contractors who erect buildings add their own systems of restraint. Many contracting groups maintain bid depositories in which copies of all bids and estimates are supposed to be filed prior to the award of the contract. In some of these depositories the bids are opened before the contract is let and the information thus obtained is used to coerce low bidders to withdraw or raise their bids. Other contractor groups maintain central estimating bureaus which calculate the cost of the job and supply the various contractors with the bids they are to make. In still other groups a central bureau determines the specifications for materials and labor to be included in the bid, and the contractor is expected to apply standard prices and labor rates to these specifications and thereby to arrive at the same bid as everyone else. Some bidding rings determine in advance which contractor is to get the job and arrange their bids so that everyone else bids higher than he.

In addition to these efforts to control their charges for service, many of these groups set up little closed markets from which they exclude outside contractors or new types of services. They may try to keep all the contracting work for local contractors or for contractors who are members of the association. They may refuse to use materials which have been bought from any source of supply other than themselves. They may insist that prefabricated products not be used in the buildings they work in. They may cooperate with contractors interested in other materials, so that no contracting group will work on a building if a product assembled at the factory is used contrary to the wishes of some other group.

Labor adds restraints

The building trades unions often participate in these policies of restraint and add new restraints of their own. In recent years they have frequently been used as the strong-arm squads for collusive agreements among contractors, refusing to supply labor where the contractors' ring wishes labor withheld. In other cases the unions themselves have refused to permit the use of new products or new processes because of their fear that the new method might make it possible to erect a house with fewer hours of labor than the old. In one city there are two unions with different wage scales getting along together with the greatest peace and amiability. The one works on public contracts and on contracts where strikes and boycotts would be most effective in the center of the city. The other, with a different wage scale, gets all the traffic will bear from the lesser contracts.

We need no amendment of the law to deal with organized restraints such as I have discussed in the last few minutes. We need only enforcement on a nation-wide scale. There are countless others, some of them equally picturesque and many of them equally absurd.

Legislative restraints

Such practices crystallize and lead to legislative restraints on trade. Many building regulations are, in reality, protective tariffs. The licensing and registration of contractors by boards of contractors affords a means of discipline over ready contractors. In one state, a contractor who must take out a license is one who undertakes "to construct, alter, repair, add to, subtract from, improve, move, wreck, or demolish any building, highway, road, railroad, excavation, or other structure project, development, or improvement, or to do any part thereof, including the erection of any scaffolding, or other structure, or works in connection therewith."

To this broad class of work which includes practically everything, the statute applies a method of rating bidders according to vague standards interpreted by the contractors themselves. It then puts handicaps on

out of the state contractors and out of the state products. This is not an isolated example.

Codes limit progress

On top of legislative restrictions are added municipal ordinances designed to restrain competition. They start out from the fact that there must be protection from fire and safeguards of minimum health requirements. They develop into legally established boycotts, particularly relating to walls, roofs, electrical work, and plumbing. I am reliably informed that plumbing which is good enough for the magnificent Department of Justice building cannot be used in private homes in many cities.

In dealing with legislative restraints of trade in building, the cooperation of private management is essential. Suppose the business organizations actually engaged in cheaper housing—and there are many such being formed—should design a house and submit it to the most expert attention and checking to ascertain if it met with reasonable standards of fire protection and health. If such plans and specifications thus tested were submitted in all of the principal cities for the purpose of actual construction, the Anti-Trust Division would be in a position to attack as a restraint on interstate commerce any ordinance or the action of any board which prevented the building of a safe and economical house.

The trouble with efforts in the past along these lines is the fact that they have been piece-meal. They have never presented to the courts a comprehensive picture. The reason why a comprehensive picture of such legislation and its effect on interstate commerce needs to be presented is obvious. Only those restraints which are unreasonable can be prosecuted. Unreasonableness is a question of fact. Actual results are what count in determining whether illegal restraints exist. No court can be expected to weigh these results unless the entire picture is shown.

Can the anti-trust laws deal with this situation? My answer is an emphatic "Yes," as far as the law itself is concerned. I frankly admit that they have not dealt with it adequately in the past in spite of the fact that throughout the entire history of the Anti-trust Division about one-quarter of the cases have been in the building industry. The reason for that failure, however, is not in the law. It rests on two obvious principles. First, you cannot police America with a corporal's guard. And second, you cannot attack a tangle of goods and services all of which contribute to a final product—the house—by hit or miss methods. I am convinced that if we deal in a co-ordinated way with the entire fabric of restraints from the production of materials through to the final work of labor, we can get cheaper houses by freeing the industry. If we proceed on a broad front we can protect those who see the necessity of a simultaneous price drop. We can open the door for substantial price reductions in the heavy industries. We can carry on the effect of that drop by liberating the real competing contractor. And finally we can say to labor, "You can get the same thing that the heavy industries are getting: a greater annual income, based upon having more work to do during the year, without need to stretch the hours of work and the rate of pay on each particular job." Without such assurance it is certainly not fair to expect labor to take the brunt. It is neither fair nor practical to deal with any element of the situation without dealing with all.

Enforcement study begun

The initial step has been taken. Corwin Edwards, a distinguished economist, familiar with industry practices as technical director of the consumers interest and trained in anti-trust problems as assistant chief economist of the Federal Trade Commission, has been appointed to the Anti-Trust Division and put in charge of the housing enforcement program. At present he has only eight men and no travel funds. In spite of this handicap, his work has made substantial progress. He needs at least sixty men now and they will be given him as fast as funds are provided.

Obviously we must proceed with care and preparation before any nation-wide prosecution of the distribution of a product is undertaken. Our activities must also be geared with finance, planning of the use of lands, the taxation of real estate, and the like, so that our principal concern, which is the clearing away of restraints, will bear fruit in actual volume of construction.

Fatigue of Welds in Plates

Tests made at the University of Illinois to determine the fatigue strength of butt welds in ¾-in plates of carbon and silicon steel are taken to indicate the conclusions summarized below, the fatigue strength being assumed as the maximum stress to which a specimen can be subjected two million times without failure. This strength in pounds per square inch of the joints in carbon-steel plates was reduced by the stress concentration at the edge of the weld due to change in section, and can be increased by planing off excess weld metal. In these plates, the strength was slightly greater for specimens welded with the automatic carbon arc than for those welded with the hand-operated metallic arc. Peening the beads and stress relieving by heat treatment had little or no effect upon the fatigue strength.

Carbon-steel welds (except automatic carbon-arc and stress-relieved welds) showed an appreciable increase in hardness in the heat-affected zone of the plate. Silicon-steel welds showed a greater hardness in this zone, but were not excessively hard. The weld metal in silicon-steel specimens was not as hard as the heat-affected zone of the plate, but in carbon-steel specimens the weld metal hardness values were equal to those in the heat-affected zone.

A change in section and the fatigue strength of the unaffected plate are the chief factors governing fatigue failure in carbon-steel. Low fatigue strength of the weld metal and changes in section appear to be equally important as factors tending to cause failure in silicon-steel. The overheated zone was adjacent to part of the path of failure in these latter specimens which failed in the weld, so that grinding the surface of silicon-steel welds did not increase the endurance limit. Fatigue strength of welds in carbon-steel averaged 22,800 lb. per sq. in. as welded, and 25,800 lb. after heat treatment for stress relief. In silicon-steel, the average was 24,000 lb. as welded, and 23,700 lb. after planing off excess weld metal. Comparative strengths of riveted joints are given as 25,900 lb. and 25,600 lb. for carbon-steel and silicon-steel respectively. These tests and their results are recorded in Bulletin No. 310 of the Engineering Experiment Station, University of Illinois.

Solving Pipe Flow Problems With Dimensionless Numbers

A. A. KALINSKE

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Contents in Brief—In solving pipe flow problems for any fluid a plotting of the friction factor f against Reynolds' number is used. But if either the discharge or diameter is unknown the solution is a trial and error process. This article shows the development and use of two other dimensionless numbers which eliminate trial and error methods of solution.

THE MOST convenient method of correlating fluid friction data for pipes is to plot the friction factor f occurring in the formula

$$\frac{h}{L} = s = \frac{f}{D}\frac{V^2}{2g} \qquad (1)$$

against Reynolds' number, which is ordinarily designed as VD/ν, or in terms of discharge, $\frac{4}{\pi}\frac{Q}{D\nu}$. The factor ν is the kinematic viscosity. In most pipe problems either the discharge, Q, or the head loss per foot, h/L, or the diameter, D, is sought when the other two quantities are known. If the pipe diameter and the discharge is known for a given fluid, Reynolds' number, R, can be calculated, and from a curve showing the relation between f and R, the friction factor is determined for use in formula (1). For relatively smooth pipes such as steel, copper, brass, and wrought iron, the $(f-R)$ data plots as a single curve for all diameters of pipe within the range of velocities usually used. For rougher pipes different curves are obtained for different diameters, because of the change in relative roughness.

If the discharge or diameter is unknown, then the problem becomes one of trial and error if only an $(f-R)$ curve is available. For problems involving the calculation of the discharge f should be related to a parameter which does not contain the discharge. This parameter will be designated by K and is equal to $R\sqrt{f}$, or,

$$K = \frac{D^{3/2}\sqrt{2g}}{\nu} \qquad (2)$$

A plotting of f and K is shown in the accompanying figure. Note its similarity to the $(f-R)$ curve. Thus f can be determined directly knowing the fluid characteristics, the available loss of head, and the pipe diameter, and without any knowledge of the discharge or velocity.

For problems involving the calculation of the diameter another parameter must be used; one which does not contain the diameter, only the loss of head term and the discharge. This parameter will be designated by J, and is equal to $Rf^{1/3}$, or,

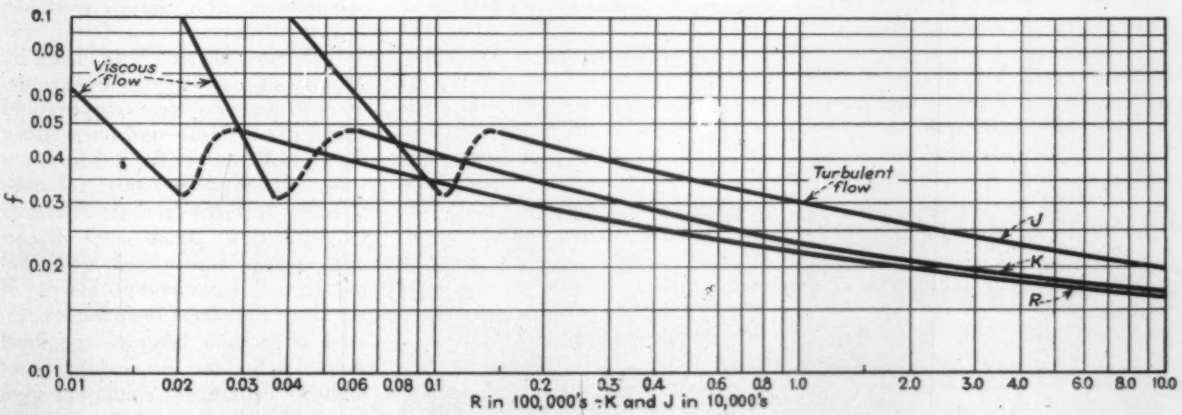
$$J = 1.33\frac{(gs)^{1/6}Q^{2/3}}{\nu} \qquad (3)$$

Thus f can be determined without any knowledge of the pipe diameter if f is plotted against J.

If data relating f to either R, K, or to J is available the other two parameters can be readily calculated. In the accompanying figure are shown $(f-R)$, $(f-K)$, and $(f-J)$, curves for data on commercial iron pipes as obtained by Wilson, McAdams, and Seltzer (*ENR* Oct. 26, 1922, p. 690). Curves such as given in the accompanying figure permit the calculation of either the loss of head, the discharge, or the diameter, when the other two quantities are known, for any fluid whatsoever using the ordinary pipe friction formula, (Eq. 1), without resorting to any trial and error calculations. It should be noted that the lower critical value of R is 2,000, of K is 360, and of J is about 1,000.

Application of data

Engineers should realize that as far as the representation of fluid friction data for pipes is concerned Reynolds' number is simply one of three dimensionless parameters to which f is functionally related, and that all three are useful. These three parameters are interrelated, and if one is known, for a given value of f, the others are known. The exclusive use of Reynolds' number in presenting pipe friction data is not entirely warranted, since an $(f-R)$ curve does not give any more general information than does an $(f-K)$ or an $(f-J)$ curve. All three are of use, depending on the type of problem on hand.



Friction factor for commercial iron pipes plotted against dimensionless numbers *R*, *K*, and *J*.

FIG. I. THE PLACID FACE OF INUNDATION DOES NOT INDICATE ITS REAL RAVAGES BENEATH.

Road Upkeep—When Floods Come

C. S. HILL

Associate Editor, Engineering News-Record

Contents in Brief — Road wear and tear, the obsolescence of structures and even the blizzards of northern winter are expected burdens on maintenance but when floods come they put the final test of an act of God on organization and management. This final article tells the story of maintenance and flood.

WHILE SNOW REMOVAL as described in the preceding article (*ENR*, June 22, p. 842) assumes on occasion of blizzard storms characteristics of an emergency operation it is flood that brings a true emergency in highway maintenance. In floods, state road departments perform a service that no other state agency is capable of performing, for it is keeping the ways of transportation open on which all other work of succor and restoration depends. And for roads this is a task for maintenance forces and equipment.

All of the four states whose road upkeep practices are drawn upon for these articles had to meet their greatest flood emergency of all time in the Ohio River flood of 1937. As in the previous five articles, one state is taken as an example of the conditions met and of the service that state road maintenance departments provided.

When the crests of the high waters were reached in Ohio, over 900 miles of state highways were submerged at one time or another. Over 600 different sections of road were under water not including 452 miles of the Ohio River Road, which was virtually all submerged from the Pennsylvania state line to the Indiana state line. For about ten days all roads leading to points across the Ohio River were closed to traffic for practically the whole length of the Ohio River in Ohio. While road inundation centered in the Ohio River flood plain, the rains that swelled the Ohio also flooded other streams and sections of road were submerged all over the state. Estimates covering the state placed the damage to highway structures at more than $10,000,000.

The repair of these damages was an after-flood operation and will not be enlarged on here. It was a task of many months and involved the usual highway construction and maintenance methods and equipment. The important information is how maintenance met flood at the time of flood. Its normal duty, as was said, was to provide roads for transportation, if not the usual roads then other roads, but it had to do more than this; it did much of the actual transporting. And, be it noted, it could do this because as has been emphasized in every previous article, road maintenance is organized under skilled engineering management with trained workmen and extensive equipment.

With many direct routes closed by flood it was necessary to arrange detours to get equipment supplies and workers to the cities and towns along the Ohio River. At the flood zone it was frequently necessary to make transfers to boats to make deliveries to destination. Maintenance department trucks transported over 250 boats and innumerable pieces of auxiliary equipment from various inland rivers and lakes to the flood zone. During the flood, 4,000 state highway department employees were pressed into service to maintain trans-

Fig. 2. As the overflowing waters recede they suck out the supporting subgrade and leave a bridge of pavement that can often be raised and underpinned.

Fig. 3. When the undermined pavement lacks strength to bridge the gap it collapses and breaks into fragments and complete reconstruction is required.

Fig. 4. On a high fill undermining is more likely to be an earth slip due to fill saturation rather than to mechanical action of receding water.

Fig. 5. The most positive flood break in the road is when scour causes a bridge to collapse; then repair fails and costly new construction is necessary.

port. These workers manned 1,050 department heavy trucks and 400 light trucks and cars, maintaining traffic over flooded roads where it was possible, setting up emergency detours, and transporting boats, supplies and medicines. Over half a million dollars were spent in these services and then all the borrowed boats and other equipment had to be taken back to their owners and all the roads had to be cleared of débris before restoration. This is the task that floods put up to the maintenance men.

Bacterial Treatment of Refuse Ineffective at Chicago Dumps

TREATMENT OF REFUSE with bacterial cultures does not accomplish its intended purpose in the prevention of putrefaction and objectionable odors, is the general conclusion of a report to Chicago following recent experiments. The treatment of mixed garbage, paper and trash was begun by the city in December, 1937, at the Tuohy St. dump, through the agency of the International Reduction Corp. When application of the process to other dumps was proposed, arrangements were made for a month's trial last March, and the Research Foundation of Armour Institute of Technology was retained to study the process during the trial period and to report its findings to the commissioner of public works.

Process outlined

The theory of the process, as described by the company's bacteriologist, P. A. Tetrault, is substantially as follows: First, the bacteria partially decompose the organic matter by using it as food. Second, they furnish heat sufficient partly to dry this product. "This is accomplished by thermogenic (heat-producing) bacteria, and the exothermic reactions are sufficient to cause a rise to 160 deg. F. This heat drives off enormous quantities of moisture and makes conditions right for the rapid development of the thermophiles (heat-loving bacteria). Lastly, this heat is sufficient to kill most of the bacteria that do not produce spores and that do not grow at high temperatures. In other words, it removes practically all the putrefying bacteria."

The point of interest to the city, says the report, is whether and how well the treatment works. Thermophilic reduction of pure garbage under certain special conditions in properly designed equipment has been successful, but this study was directed to finding the result of its operation at the open refuse dumps. Trucks and trailers deposited the material 8 or 10 ft. from the edge of the dump, and a prepared mixture of thermophilic and thermogenic bacteria, together with gypsum, limestone dust, peat, molasses and wood ashes, was shoveled upon it from the company's trucks, after which a bulldozer pushed the mass to and over the edge of the dump. Actually, the bulldozer does not mix the mass by turning it over and over, but rather compacts it in front of the blade. In this respect, therefore, the mixing was inadequate.

Thermophilic bacteria grow best at temperatures of 104 to 180 deg. F. with 135 deg. as the most favorable. In this process, the temperature is to be reached through the liberation of heat by the thermogenic strains. But such temperatures were not found in the dumps in general, and at the Tuohy St. dump, where the process has been in use for more than a year, several days were required for fresh seeded garbage to reach the desired temperature. Furthermore, this temperature never reached the surface. And it is the surface layer, of course, that can most easily become a nuisance.

On the whole, conditions in the dumps tested were not suitable for proper growth of the bacteria, and as cold weather checks their action a nuisance may be caused in spite of the treatment. At the open dump, the temperature of the mass does not regularly rise high enough to destroy the putrefactive bacteria. Inquiry of neighboring residents showed general complaint as to odors and dust, and the presence of flies, mosquitoes and rats. This applied even to the Tuohy St. dump after many months of the treatment.

For laboratory tests, four metal cans were filled, two with plain and treated city garbage and trash, and two with plain and treated pure garbage (without papers and trash) from a cafeteria. In an 8-day period, the start and final temperatures were 87 and 80 deg.F. for the untreated and 82 and 82 deg. for the treated city garbage; 77 and 78 deg. for the untreated, and 87 and 90 deg. for the treated cafeteria garbage. In both types of garbage the treatment caused 30 to 40 per cent more settling of the mass in eight days. Aerobic conditions prevailed although the garbage was not agitated. All four cans gave out objectionable odors throughout the test. From these tests and from observations at the dumps it is evident, according to the report, that the bacterial treatment will not cut down the odor of garbage a week or less in age, nor of garbage which lies exposed on the top or bank of a dump.

Conclusions

Conclusions derived from the study of operations during the trial-month, March, 1939, may be summarized as follows:

1. Thermophilic bacteria can be made to reduce garbage with a minimum of public nuisance, but not under the conditions found at the open dumps of Chicago. Therefore, the treatment as now practised at the Tuohy St. dump cannot be recommended as a solution of the disposal problem.

2. With a separate collection of garbage, excluding trash, ashes, and other forms of refuse, it is possible that by the erection of a number of reduction plants, the bacteria may be used to produce a fertilizer.

3. If dumping is to be continued, the material should be placed in thin layers, and each day's material covered immediately with ashes and earth. High banks defeat this purpose and are not recommended.

4. Mosquito breeding places in the vicinity of the dumps should be eliminated or treated. While these breeding areas are not always occasioned by dumping operations, they are causing a nuisance for which the dumps are blamed.

Fill Disposal of Refuse Successful in San Francisco

***Contents in Brief—Fill-and-cover disposal of mixed garbage and rubbish is declared successful by San Francisco authorities after six years' trial. The following account of operating experiences is based on a recent inspection made by the editor of* Engineering News-Record.**

SIX YEARS' EXPERIENCE with fill-and-cover disposal of refuse in San Francisco demonstrates the method to be satisfactory and economical, according to Alfred J. Cleary, chief administrative officer of the city. A ten-year contract for collection and disposal which the city made with the Sanitary Fill Co. (formed by collectors' organizations) has functioned efficiently and smoothly and will be continued without change for the remainder of the contract period.

No complaints of nuisance from the fill have been received for several years, and rats and flies are absent. There were many complaints during the first year of operation after filling began in October, 1932. In an interview with the editor of *Engineering News-Record*, Mr. Cleary stated that some of these may have been caused by a fertilizer plant near the fill site. No houses are nearer to the fill than half a mile, while the fertilizer plant is closer to dwellings. Harbor and sanitary authorities have made no complaint on the score of pollution of bay waters.

The fill site is low ground and land under water on San Francisco Bay just south of the city line, in San Mateo County. Close inspection is maintained by a city and by a county representative. The city inspector's duties include enforcement of the contract specifications, which call for a minimum of 2 ft. of cover over 6-ft. depth of fill. A description of the methods in use was published in *ENR* Feb. 27, 1936, p. 314, and Oct. 18, 1934, p. 501.

Incineration discontinued

Originally the fill site was used as a dump for ashes from the Scavengers' Union incinerator, located in the city. Incineration gave rise to many complaints from citizens living near the incinerator, and in 1932 a review of disposal methods was undertaken by the city. At that time, Mr. Cleary says, "a line of abandoned incinerators extended through the state, practically paralleling the line of the old missions." The prevailing experience with incinerators was discouraging while Seattle and a number of the Coast cities were finding fill-and-cover disposal efficient and cheap. The report recommended this method, and a contract was entered into with the Scavengers' Protective Union (a combination of collection companies) permitting fill disposal under controlled conditions. Even before the contract was drafted, however, it became necessary to resort to fill disposal because of shutdown of the incinerator. Later, the scavengers contracted with the Sanitary Fill Co. to handle the disposal, including loading from collection trucks to railway cars, rail transportation to the fill site and all operations at the fill.

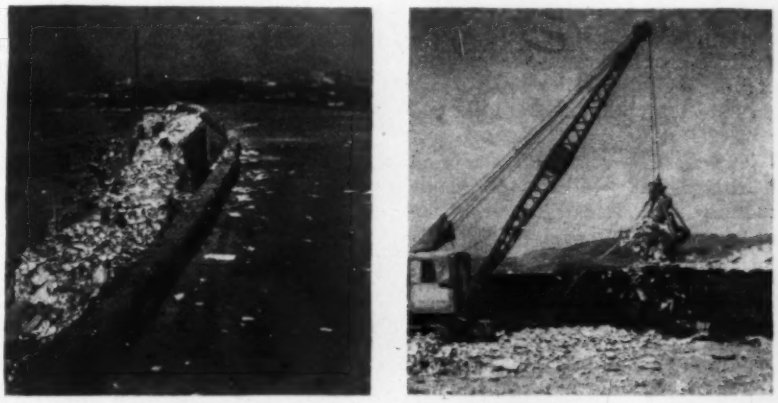


Fig. 2. Refuse is dumped into railroad cars from a loading ramp (left), and unloaded at the fill site with crawler cranes (right).

ENR Staff Photos

Fig. 1. San Francisco fill-and-cover refuse disposal area, where operations have been conducted during the last six years. Mixed garbage and refuse, hauled in on railroad cars, is deposited on the edge of the fill and covered with earth.

Fill methods

Mixed refuse collected from householders by the scavengers is trucked to a track-side loading ramp at Sixth and 16th streets, in the industrial

Fig. 3. Tractors distribute and compact the refuse at the edge of the fill which has a working front of 50 to 350 ft. Earth cover is applied on the forward face as well as on top of the fill.

area, where, after passing over a platform scale the trucks are run up the ramp and back-dumped into open-top cars. Buckets of unmixed restaurant garbage are sold to hog-feeders at the ramp; all other material goes into the cars. Trains of 20 to 30 cars move to the fill, about five miles away, where they are run out on a spur track laid 50 to 250 ft. back of the face.

Two crawler cranes with clamshell buckets unload two cars at a single spotting and place the material on the outshore side of the track. A 75-hp. tractor with bulldozer blade distributes the refuse, shoving it forward to the face and at the same time bringing the fill up to the desired elevation and compacting it. The working width thus ranges from 50 to 350 ft. A floating boom at the front of the fill prevents the escape of trash.

As this work proceeds, trucks bring cover soil from an adjoining hill where a shovel works continuously loading four trucks for cover supply. The bulldozer spreads, levels and compacts the cover as dumped along and over the fresh fill by the trucks. Care is taken to push cover soil down over the forward face of the fill, to seal this face as well as the top. This fill-and-cover sequence produces inclined rather than horizontal layers of alternating refuse and soil, and settlement of the fill at the toe further increases the slope of the stratification. No disinfectant spray is used.

The shallow water at the site is underlaid by 50 to 80 ft. of soft bottom, into which the fill settles, forcing up a mud wave that extends out some distance. Calculations of fill volume and area indicate that the refuse extends to a maximum depth of 30 to 35 ft. below water at the present face, in addition to the 20 ft. above water level, according to L. P. Brassy, of the Sanitary Fill Co.

Operations are so handled as to produce a final fill surface 12 ft. above water (after ultimate settlement) or level with the adjacent land. The front of the face is built up to 10 to 12 ft. higher and the surface slopes down to final level for a distance of some 800 ft. back. More than half the settlement develops within a month or two, but final settlement is not obtained in less than a year. When the settling opens cracks in the cover, especially near the front of the fill, it is required that they be closed at once with additional cover, to prevent discharge of offensive liquids or gases.

Present fill operations involve about 180,000 tons (550,000 cu.yd.) of refuse per year and about 210,000 tons of cover soil. Mr. Brassy gives the initial weight of refuse as 25 lb. per cu.ft., its weight as compacted by the bulldozer as 35 lb., and its final weight as 45 to 55 lb. Operating costs are given as 33 to 35c. per ton for loading and freight, and about an equal amount for unloading, spreading and covering at the fill.

Road Tax in Illinois

In opposition to suggestions for reduction of license fees on motor vehicles in Illinois, the Illinois Municipal League has issued a statement, in pamphlet form, showing that for 1938 the income from these fees was $21,152,879, while fixed charges against the road fund were $22,910,285, the deficit being made up from the gasoline tax revenue. These fixed charges include principal and interest on the outstanding road bonds ($9,670,260), and also upkeep of state roads, administration and engineering costs, state highway police and automobile departments, and some other items. With a 50 per cent cut in the license fees, the income for 1940 would be $11,295,000, or only $1,865,000 in excess of the amount required to meet the principal and interest charges on the outstanding road bonds. Or, with a proposed flat passenger automobile license fee of $5 per car, the income would be $15,300,000, barely enough to make the payments on bonds and provide for maintenance expenses.

As to the tax on motor fuel, which is the only other source of state road income, and is estimated at $40,000,000 for 1940, only one-third goes to the state and with certain charges deducted only $3,800,000 would be available for matching federal aid and carrying out necessary reconstruction and improvement work. Furthermore, authorized diversions from this tax to purposes other than road and street improvement would amount to $6,356,250. On the other hand, 440 miles of road and 170 bridges already need improvement, at an estimated cost of $23,535,000. In addition, for the next five years about 328 miles per year will need to be rebuilt, while in 1938 only 70 miles were reconstructed, owing to the financial limitations.

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Japan's Submarine Tunnel

Headings have met in the tunnel for the Japanese Imperial Government Railways under the Shimoneseki Strait, to connect the lines on the main island of Hondu with those on the small island of Kyushu. It will be about two miles in length and will eliminate the present car-ferry service between Shimoneseki and Moji.

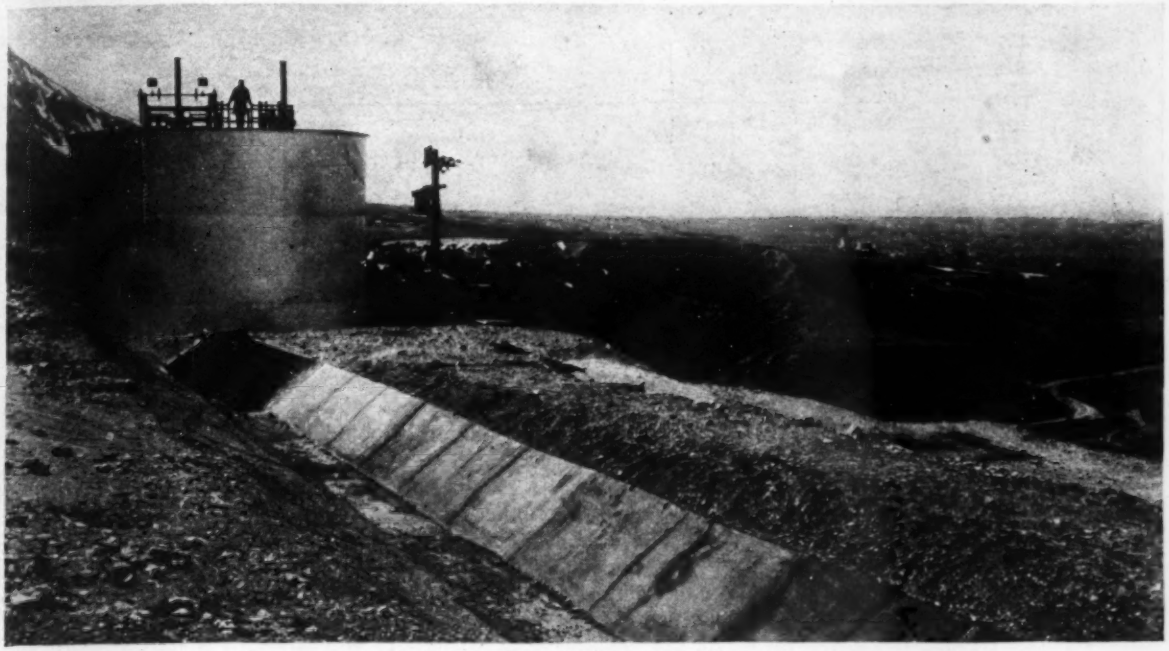


FIG. I. SURGE TANK WITH WATER APPORTIONING GATES FOR OGDEN CANYON CONDUIT

Conduit Control Simply Solved

C. R. BURKY

Engineer, U. S. Bureau of Reclamation, Denver, Colo.

Contents in Brief — Keeping down pressure on wood-stave pipe line and apportioning of water, part to power plant penstock and part to open canal, presented a complicated control problem on the Ogden Canyon conduit. Two sets of shaft spillways and an ingenious surge-tank gate arrangement provide simple solution.

CONSTRUCTION of the Ogden canyon conduit involved two main hydraulic problems. One was at the end of the conduit to accomplish a division of flow at 100-ft. pressure and one was to keep down the cost of wood-stave conduit by pressure regulating devices. Both were solved by the methods illustrated by the accompanying drawings. Briefly, the Ogden canyon conduit extends from Pine View Dam near Ogden, Utah, to the surge tank where the water remaining at this point is divided, part to the penstock of the Utah Power & Light Company's power plant and part to the Ogden-Brigham irrigation canal. The conduit is 5 miles long and except for short sections is wood-stave pipe 75 in. in diameter. A diagrammatic profile, also indicating the control devices, is shown by Fig. 2.

The maximum water level in the Pine View reservoir is at El. 4,872, while the required elevation of the water in the Ogden-Brigham canal is 4,760. The power plant is 450 ft. lower in elevation than the canal and the penstock is 4,500 ft. long. The South Ogden high line canal takes off from the conduit ½ mi. upstream from a surge tank. To make the required division of water, 35 cfs to the South Ogden high line canal, 120 cfs to the Ogden-Brigham canal and 125 cfs to the power company's penstock, it was imperative to reduce the pressure at the end of the conduit. With a closed conduit the pressure with a small flow would be 100 ft. at the end of the conduit. In addition to the difficulty attending the division of water at a pressure of 100 ft., the expense for pipe bands was an item to be considered, and the regulating devices installed made a difference of 1,800,000 lb. of bands considering only the difference of static head.

No suitable location existed for a wasteway at the end of the conduit, but at a point ½ mi. from the end, where the conduit passes through a small tunnel and where the South Ogden high line canal diverts from the conduit, a spillway site was developed. A combination structure was built here with a siphon spillway, with a lip placed at El. 4,770, 10 ft. above the water surface of the Ogden-Brigham canal. This reduced the variation of head at the end of the conduit, due to surges, for summer operation, to 10.5 ft. and reduced the surge elevation for a shutoff by the power company in the winter time to El. 4,778.15.

Details of spillways

The outlet for the conduit is through a tunnel at the right end of Pine View dam, Fig. 2. Near the axis of the dam a 5 x 6-ft. high-pressure

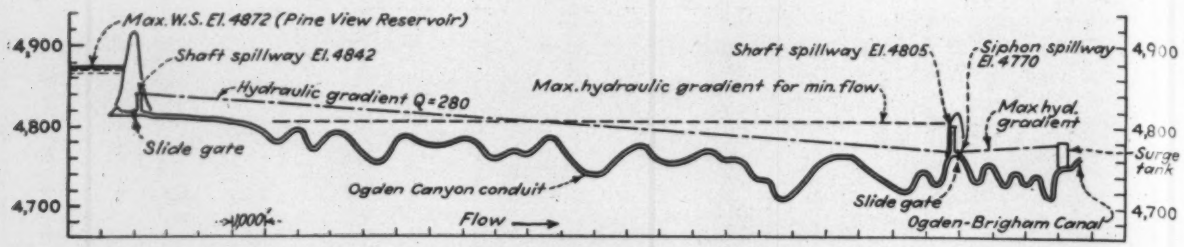


Fig. 2. Diagrammatic profile of Ogden canyon conduit showing location of control devices.

slide gate is provided to control the water to the conduit. Below the gate the water is carried in a 72-in. steel pipe for 465 ft. to a point outside the tunnel where it joins the 75-in. wood stave pipe. A vertical shaft spillway is provided in the 72-in. steel pipe with its lip at El. 4,842. This insures enough pressure for friction at full capacity and limits the head on the pipe. The conduit remains closed except for air outlets and blowoffs from this shaft to the second shaft spillway 4.7 mi. below.

This second shaft spillway is located at the upstream end of the main siphon spillway structure, Fig. 3. The shaft is concrete lined and is 4.5 x 6 ft. on the inside except that the upper 10 ft. is tapered to 8 x 8 ft. at the top. The spillway lip is at El. 4,805. At the downstream side of this shaft a 4.8 x 6-ft. slide gate is provided. This gate is intended to be partly closed at low flows so as to insure that the pipe remains full of water at the high points; the gate can also be used to stop the flow of water beyond this point and retain the pipe full of water above it.

The siphon spillway is located in a tunnel and the water flows out through an adit and down a rocky hillside. This spillway consists of two 4 x 3-ft. barrels and has a capacity of 360 cfs. Under some conditions of flow at the surge tank below, 80 cfs will discharge back from the surge tank to the spillway, which added to the full discharge of 280 cfs coming down the pipe puts a demand of 360 cfs on the spillway for a brief interval.

The two barrels have lips at El. 4,770. The hoods of these barrels are placed 6 in. and 12 in. respectively above this elevation so that for a small excess of water only one barrel will act. At certain settings of the gate just below the shaft spillway, a hydraulic jump would form in the spillway structure and sufficient length was provided between this gate and the siphon spillway to insure completion of the jump. The floor of the spillway structure is at El. 4,759.56, providing plenty of depth to overcome the hydraulic jump. All of the spillway structure is in the tunnel and should give little trouble during winter operation.

At the lower end of the spillway structure a 3 x 3-ft. slide gate is installed to regulate the discharge into the 31½-in. pipeline which is carried across the Ogden River to the South Ogden high line canal. The bottom of this gate is at El. 4,759.56 and this should insure plenty of water to this canal under any conditions of flow. The conduit leaves the spillway structure just below the siphon spillway and extends 2,900 ft. to the surge tank.

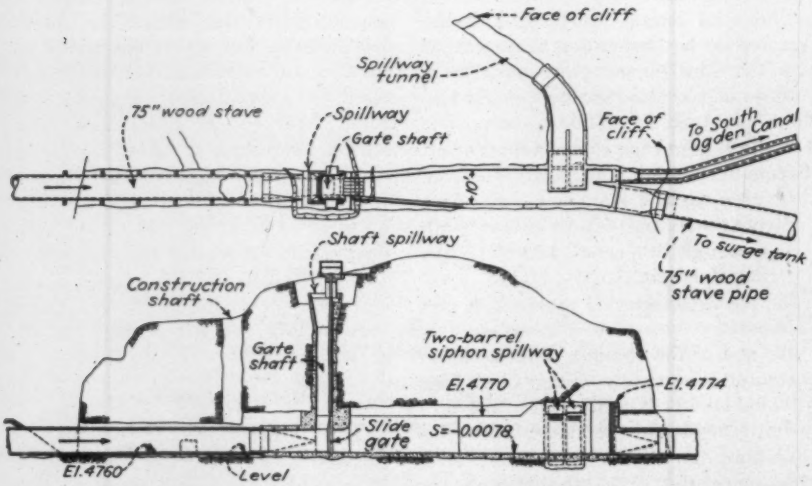


Fig. 3. Shaft and siphon spillways and canal takeoff forming second control.

Division at surge tank

The surge tank (Fig. 4) is 34 ft. 10 in. in diameter and 27 ft. 5 in. high. It is of steel set on a concrete base. The conduit changes from wood pipe to concrete 90 ft. upstream from the tank and goes under the concrete base to discharge upward into the tank. All flows into and out of the tank are controlled by apparatus within the tank. The floor of the tank is at El. 4,754.

The discharge to the power company's penstock is controlled by a 4 x 5-ft. slide gate but above this gate a concrete well is installed with top at El. 4,758. Inside this well is an open vertical cylinder which can be raised or lowered to insure sufficient head for regulating the water to the Ogden-Brigham canal. This well and cylinder are arranged so that all water to the penstock passes through them before reaching the 4 x 5-ft. gate. Without this arrangement the penstock might draw the water down below the elevation required for the canal. The elevation required inside the surge tank for full discharge to the canal is 4,762.

The water to the canal goes first through ports in a vertical steel cylinder 5 ft. in diameter. This cylinder extends from the floor to the top of the surge tank and is closed except for these ports. There is an opening at the bottom through which the water passes to the canal. There are two ports at opposite sides of the cylinder, with openings 3 ft. wide and 4 ft. 7 in. high. The openings are designed to take 10 per cent more than the full

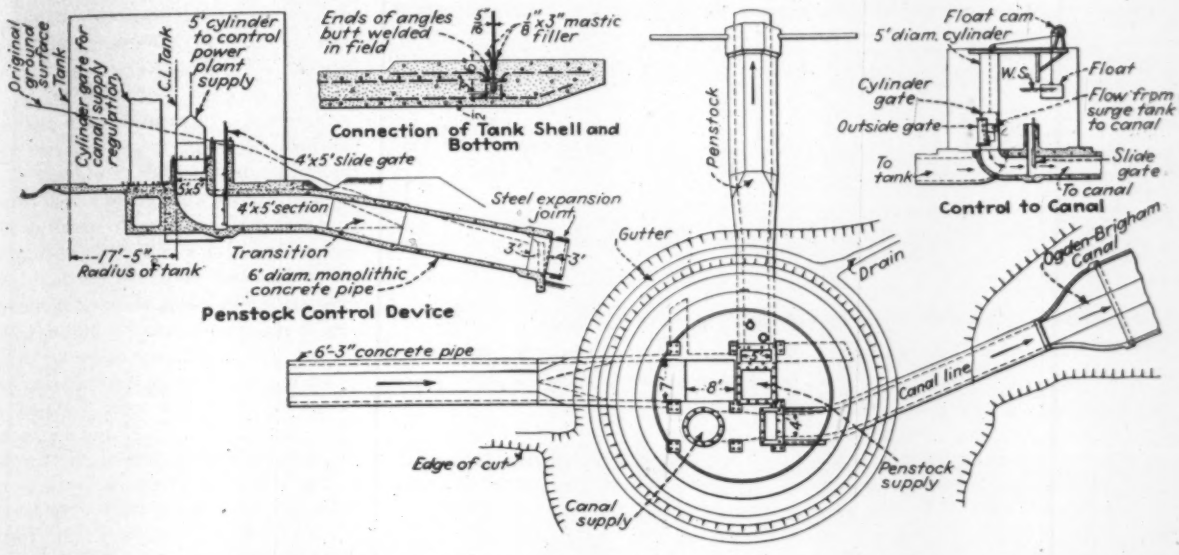


Fig. 4. Surge tank showing gate arrangement for division of water to power plant penstock and to open Ogden-Brigham Canal.

normal discharge of the canal with water at El. 4,762 in the surge tank. A liberal loss was allowed from the canal back to the tank and was assumed at 1 ft. For full opening of the cylinder ports a 1-ft. head was allowed between the inside and outside of the cylinder. Between the cylinder and the canal a 4 x 5-ft. slide gate is installed as a method of closing off the supply to the canal and also as a means of maintaining the water level inside the cylinder at elevation 4,761. A cylinder gate with vertical motion is installed inside the vertical 5-ft. cylinder and is regulated by a float, through cams and pulleys, so that if the water should rise in the surge tank above El. 4,762, the cylinder gate would be lowered to close off a portion of the ports in the cylinder. This arrangement is adjusted for a maximum rise of 10.5 ft. above the normal operating level of 4,762 in the surge tank. Circular gates outside the cylinder are provided for closing off a portion of the port openings for less than maximum discharge. These gates move horizontally so that the port openings are of less width but of the same height. In this way a rise of water in the surge tank would lower the cylinder gate inside the 5-ft. vertical cylinder so as to close the same proportion of the ports as at full discharge.

Directing officials

The general design of the Ogden Canyon conduit was made by the writer under the supervision of H. R. McBirney, senior engineer, canals, and J. L. Savage, chief designing engineer. The conduit was built under the supervision of J. R. Iakisch, construction engineer. All activities of the bureau are under the direction of John C. Page, commissioner, and R. F. Walter, chief engineer.

Observations at Boulder

MANY INSTRUMENTS to check on movements, temperature changes and the like were installed in Boulder Dam at the time it was built and have been checked regularly since that time. At the request of *Engineering News-Record*, the Bureau of Reclamation has prepared the following statement concerning those observations:

Research observations at Boulder Dam, made periodically since the days of construction, have shown no deterioration of concrete, no cracking of structural significance, no differential movements of elemental blocks, and no disturbances due to the recent minor earthquake shocks which have been attributed to the filling of Mead Lake. Some crazing and other cracking has occurred at exposed surfaces, particularly during the first year after the completion of the dam. In no case, however, have the detailed surveys of such phenomena disclosed any cracking of appreciable magnitude, any continuous extension of individual cracks, or any progressively increasing widths of the minute crack openings. The 39 crack surveys made thus far have shown that the cracking of the concrete at Boulder Dam has been much less than at most large concrete dams.

Research observations at Boulder Dam are being made periodically at more than thirteen hundred installations of measuring equipment. These installations include uplift pressure pipes, joint meters, strain meters, resistance thermometers, tiltmeters, and seismographs. They also include targets, plumb lines, extensometer inserts, benchmarks and other reference points at which direct measurements are continuously being made to determine radial and tangential movements of the dam, spreading of the canyon walls, vertical settling of the dam and adjacent topography, changes in width of joint openings, and other related characteristics of the structure.

A recent inspection of the several thousand observations made up to the present time disclosed no evidence of any abnormal movements of the dam or any of the elemental blocks of concrete which make up the dam. The measurements to date have checked very satisfactorily with the analyses made in connection with the design of the structure. The operation and service record of the dam has been entirely adequate.

Architectural Concrete Surface For Los Angeles Terminal

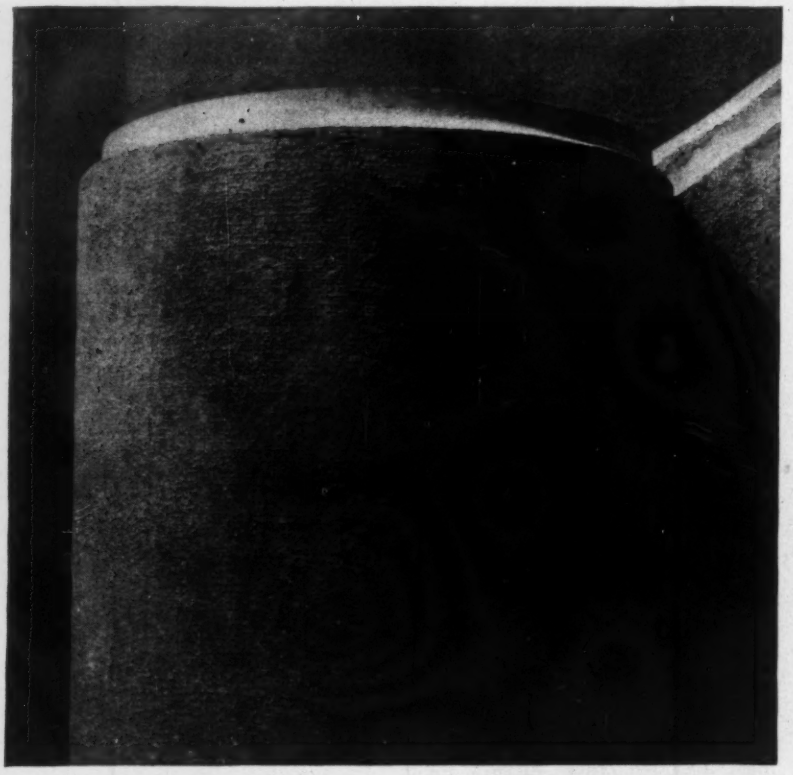
C. W. PIERCE

Chief Engineer, Viber Company, Los Angeles

Contents in Brief—A pleasing concrete surface has been obtained for much of the new Los Angeles station's interior and exterior by lining the forms with a heavy-textured wood-fiber board. Freedom from glare and surface cracking are also features of this surface.

UNIQUE concrete surface texture, obtained by lining forms with Celotex, is an attractive feature of a large part of the exterior and interior walls of the new Los Angeles Union Passenger Terminal, which was opened May 7 (*ENR* May 4, 1939, p. 625). In addition to its attractive appearance, the surface is noted for its glare-reducing properties and freedom from crazing, properties which can be seen plainly in the accompanying close-up photograph of a newel post at the foot of an outside stairway of the terminal.

After considerable experimentation it was found that most satisfactory results were obtained with Celotex fiber board of the roughest commercial texture, $\frac{7}{16}$ in. thick, treated with a single, thin brush-coat of boiled linseed oil, which was allowed to stand for several days; the fiber board was applied to solid, smooth, firm backing (preferably plywood), with as few nails as possible. Great care was taken not to drive or sink the nail heads below the outside surface of the Celotex, where their impressions would be cast on the finished concrete surface. Closely butted joints eliminated all need of sealing material,



Newel post of an outside stairway at the new Los Angeles Terminal, showing surface effect produced by lining forms with rough building board.

fibers being smoothed by rubbing with the ball of a hammer. Celotex capped spreaders were used sparingly.

Closely spaced tremies were used to prevent splashing fresh concrete on the lining and to expedite placing. Reinforcing bars were closely spaced to conform with earthquake-resisting requirements. The concrete was brought up in lifts not more than 2 ft. high, and was vibrated at about 2-ft. intervals horizontally with Viber flexible electric vibrators, care being taken to place the vibrators in the concrete between the inner and outer curtains of steel, where they could not come in contact with the lining of the forms.

The forms were removed not more than five days after the concrete was placed to avoid "freezing" the form lining to the concrete. After the Celotex was loosened, it was shifted slightly, left against the concrete and kept wet. This gave effective curing. The superior results obtained by this method will probably justify the extra expense on many jobs where distinctive quality is a major consideration in designing the building.

C. A. G. Weymouth of the Raymond G. Osborne Bureau of Tests at Los Angeles is responsible for the high quality concrete obtained throughout the 50,000-cu. yd. job, having designed the mixes and prescribed the methods employed for placing. (*ENR*, Dec. 29, 1938, p. 818).

The terminal construction was under the direction of A. J. Barclay, construction engineer for the owners. Parkinson & Parkinson, Los Angeles, were consulting architects. Architectural and engineering committees represented the Santa Fe, the Southern Pacific and the Union Pacific railroads, the owner. Robert E. McKee was general contractor for the main buildings.

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Chicago Bridge Removed

The State Street 250-ft. double-leaf bascule bridge over the Chicago River has been dismantled and removed, and its piers demolished by blasting, in preparation for the construction of the river section of the rapid-transit subway tunnel. The bridge will be replaced later by a structure of similar type having a width of 108 ft. (instead of 70 ft. as in the old bridge) and costing some $3,500,000.

Pier Deck Lowered in One Piece Using Large Threaded Hangers

Contents in Brief—A section of the steel beam and girder upper deck of Pier 99 in New York City, 54x340 ft. in area, was lowered 3½ ft. by means of threaded rods welded to column brackets and to tops of girders.

TO CONVERT Pier 99 on the Hudson River in New York City to a refuse disposal station for the Department of Sanitation required lowering the outboard portion of the upper deck of the pier shed 3½ ft. A floor area 54 ft. wide, full width of pier, and 340 ft. long was lowered in five days with a crew of four men using threaded rod hangers fastened to column brackets and to the tops of main transverse girders. The floor system weighs 250 tons.

Type of construction

The upper deck system consists of 60-in. built-up girders spanning 54 ft. between columns in the pier shed walls, 15-in. floor beams framing into the girders and a wooden floor. At the second floor level the columns are spliced, the smaller upper section is set back from the inner face of the column below. The heavy transverse girders were fastened to the columns by angles and also rested on curved brackets or knee-braces.

First, the wooden floor system was removed, exposing the bare steel framing. Then a bracket about 13 in. long made up of two 3-in. 6-lb. channels, placed back-to-back 2¼ in. apart, was welded to the top columns just above floor level. These brackets projected out over the girders and were reinforced by ⅝-in. square posts welded between inner faces of channel flanges. They rested on a ¾-in. square block welded to the top of the lower column and were welded to the inner flange of the outside face of the upper column, as shown in Fig. 3. A ¾-in. bearing plate, bored to take a 2-in. rod, was welded across the top of the channels near their exposed end, and a ¼-in. washer placed on top of the plate. Then a 2-in. rod, threaded its full length of 4½ ft., was set through the hole in the plate and its lower end welded to the top of the girder. A nut was run down from the top of rod to bear against the washer, completing the lifting assembly.

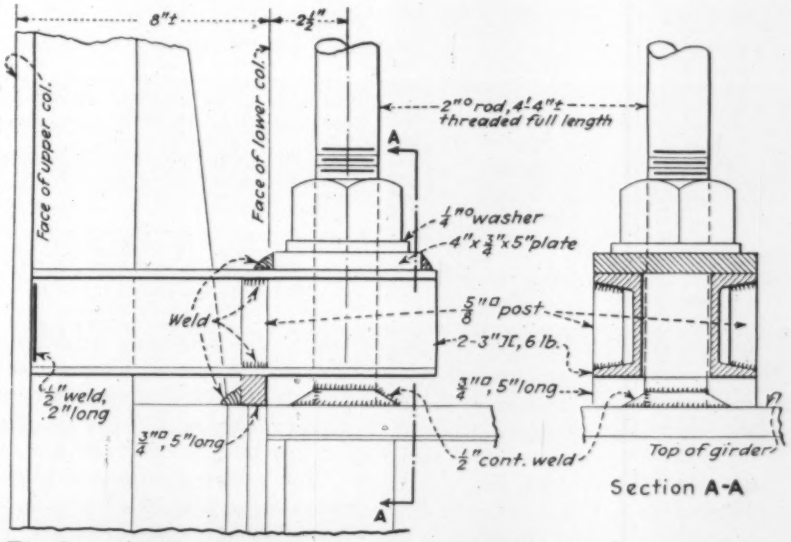

Fig. 2. The hanger assembly was made up of channel brackets, welded to columns, supporting threaded rods welded to tops of girders.

Fig. 1. Large expanse of pier deck lowered in one operation by hanging the main girders from threaded rods attached to the columns.

The girders were cut loose from the columns by burning through the corners of the connecting angles. Along the north wall the knee braces were cut loose in the same manner, being left attached to the girders. Because of subsequent structural changes in the columns below, along the south side of the pier, the south end knee braces were cut out, leaving their connecting angles attached to the girders and columns. The floor-beams were cut loose at the end bays. To compensate for the loss of rigidity in the columns by removal of the knee braces, temporary sway bracing of cables and turn buckles were inserted in the second story.

After all the jacks were installed and the girders cut loose, actual low-

Fig. 3. Detail of one of the hangers in operation.

ering of the floor was a simple operation. The jacks were lowered about 1 in. at a time in rotation by one man starting at one corner and working around the walls. It was found that the individual girders could be dropped up to 1 in. without binding or putting excessive stresses into the floor framing.

After the lowering was completed, the girders and attached brackets were welded to the columns along the north wall, and the end bay floorbeams were welded to the end girders. South ends of the girders were involved in subsequent structural alterations that were made in the south wall of the building.

Direction of the work

The job was done for the New York Department of Docks, John McKenzie, commissioner, Joseph M. Meehan, chief engineer, Joseph Halpern, division engineer and A. J. Duggan, resident engineer. The Osborne Construction Co., Inc., New York, designed the method and carried out the work under the direction of Arthur Sitzman, president, and Edward S. Klausner, chief engineer. Gilbert Fish was consultant in the welding.

Pond Treated with Salt Water To Make Bottom Impervious

A 7-ACRE LAGOON which is an important landscape feature in the World's Fair grounds at San Francisco was put in service early in January after an unusual treatment of the bottom to decrease seepage losses. Because of the conditions obtaining it was possible to make an entirely successful treatment with sea water.

When the lagoon was constructed, excavation was followed by placement of a 10-in. layer of carefully selected material rolled with a 10-ton, flat roller until it was well compacted. No sheepsfoot roller was used. Some sprinkling was done; i.e., moisture content was controlled to some extent. The material in the 10-in. layer is a calcium clay of loamy characteristics, selected for this use because it was found to be uniformly graded from fine sand to clay and hence should make a tight lining when properly placed. The material was characterized markedly by flocculation.

After rolling operations were completed, an area of 100x100 ft. on the lagoon bottom was leveed off and filled with fresh water to a depth of 18 in. to test seepage losses. This test showed seepage loss of 1 in. per 24 hr. with serious softening of the clay lining—a very discouraging result in the face of need for conserving water, keeping costs low and making it possible to plant aquatic vegetation early.

Laboratory tests on the material used in the 10-in. layer led to a decision that it could be sealed with salt water because sodium ions in sea water would replace calcium ions in the wet clay and the calcium and excess sodium could be washed out, thus effecting deflocculation of the material.

Accordingly the entire lagoon was flooded with salt water to a depth of 18 in. and kept at this depth for 45 days. During this period seepage losses continued at the rate of ¾ in. per day but softening of the clay was relatively very much less. The salt water then was pumped out and the lagoon (capacity 7,200,000 gal.) was filled to the full 36-in. depth with fresh water.

The rate of loss commenced decreasing immediately and since April 1 has been less than 0.10 in. per day. This degree of impermeability was very satisfactory.

This treatment, carried out at a cost of a few hundred dollars, took the place of the alternate method which would have used a ½-in. layer of crushed bentonite and a 6-in. layer of sand estimated to cost about $15,000.

The treatment was devised and applied by Charles H. Lee, chief, division of water supply and sanitation, Golden Gate International Exposition, who will present a complete report at the Am.Soc.C.E. convention to be held in San Francisco next July.

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Foundation Seismic Data

In preparation for the Hoover War Memorial Library, on Stanford University campus, the University recently obtained cooperation of the Seismological Field Survey of the U. S. Coast & Geodetic Survey in making a series of foundation tests at the building site. A vibration machine (that rotates up to 350 lb. of unbalanced load on a 1½ ft. effective radius at speeds up to 750 rpm) was used to set up vibrations and also small charges of powder were exploded at depths up to 160 ft. 1,000 ft. from the instrument. The objective was to get information that might give some indication of the natural ground period.

Readings were taken with the shaking machine set in two directions, 90 deg. apart, both at the bottom of an 11-ft. pit and at ground surface. Vibrations were recorded at ground surface and also in test pits. Records were made with a Benioff seismometer in which four instruments at different locations make simultaneous records at the central recording point on the same moving picture film.

Concrete Plant Serves Both Barges and Cars

***Contents in Brief** — Concrete for piers of the Tacoma Narrows Bridge had to be delivered by water, but hazards menaced floating equipment and concrete for the anchorage had to come from the same mixers. The solution was a plant on piles arranged for convenient delivery either to shore or barges.*

A CHANNEL permitting the passage of tugs and barges immediately beneath a concrete mixing plant supported on piles, was the solution of a problem in supplying concrete to piers of the Tacoma Narrows Bridge. Because the piers are in deep water some distance from shore, water delivery was necessary. However, a floating concrete plant would have been affected by winds and tides and there would have been the hazard of collisions in foggy weather. Moreover, some 20,000 cu. yd. of concrete for the west anchorage which is on land must come from the same plant. These requirements were all met effectively by a plant on piles close to the west shore, arranged as shown in the accompanying illustrations.

The plant is designed to deliver 80 cu. yd. per hr. and the total requirement is about 90,000 cu. yd. (not including the east anchorage and some small piers adjacent to it, handled under a separate contract). Because of the convenient access for the delivery of raw materials by barges, it was unnecessary to provide for much storage and the bins over the mixer were built for a capacity of only 150 cu. yd.

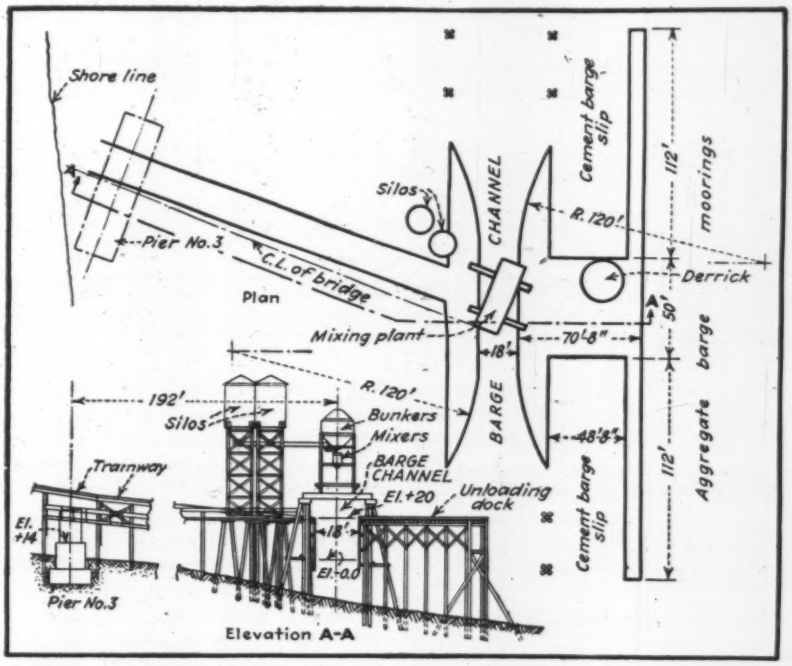

Fig. 2. Plan and elevation of the wharf structure built expressly for the mixing plant and materials unloading depot.

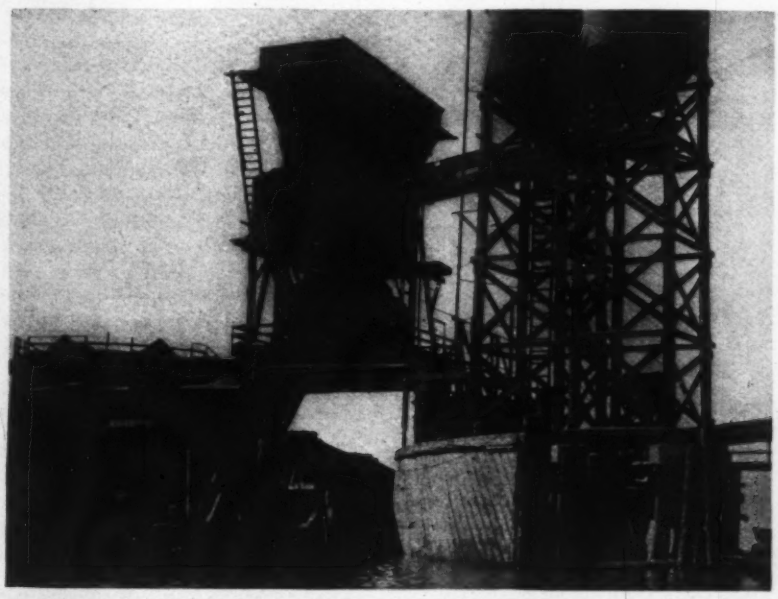

Fig. 1. This mixing plant, supported on piles, could deliver to buckets on barges in the channel immediately under the mixers, or to a skip on the inclined tramway.

The pile structure, in addition to supporting the mixing plant, includes two slips for cement barges and a mooring space 275 ft. long for tying up aggregate barges. A derrick mounted on the wharf operating a clamshell transfers materials from the barges to the bins over the mixers. Bulk cement is delivered on barges from which it is conveyed by pneumatic pumps to the silos above the mixing plant.

The mixing plant, a standard installation designed for 80 cu. yd. per hr., at times produces at the rate of 110 yd., and averages 90 cu. yd. per hr. It contains two 2-cu. yd. tilting mixers. Mixing time is specified as 2 min. for all concrete to go below

water level and 1 min. for concrete above high tide.

The hopper into which the mixers discharge has two radial gates; beneath is a carriage, mounted on tracks transverse to the channel, supporting the elephant trunks. This carriage permits the elephant trunks to be rolled aside so the channel is unobstructed when the tug passes through.

The channel width between the strings of fender piles is 18 ft., just allowing convenient clearance for the 16 x 50-ft. barges. Each barge has spaces for 6 buckets, but only four were put on at the mixing plant, thus leaving two spaces on each barge for the empty buckets waiting when the barge arrives at the pier. At the pier the buckets are lifted from the barges by two derricks mounted on the caisson. Concrete is dumped into an 8-cu. yd. hopper from which it is buggied to forms.

Construction of the Narrows Bridge is under direction of the Washington State Toll Bridge Authority; Lacey V. Murrow, chief engineer; Clark Eldridge, bridge engineer; and C. E. Andrew, consulting engineer. The general contract is held by a combination of three firms: Pacific Bridge Co., General Construction Co., and Columbia Construction Co. Work has been carried on under the supervision of men from the Pacific Bridge Co. in the following capacities: general manager, Ralph T. Keenan; superintendent, A. E. (Jack) Graham; and chief engineer for the job, Theodore M. Kuss.

Road Laboratory Test Apparatus

Contents in Brief—Recent test apparatus described in the report of the Road Research Board of Great Britain working in collaboration with the Experimental Work on Highways Committee of the Ministry of Transport.

A VARIETY of testing devices, not familiar in American practice, are presented here from the pages of the latest report of the Road Research Board on its extensive research work in cooperation with the British Ministry of Transport. Each device has had its trial in actual use and has served its purpose to the approval of the research technicians.

Subsoil Swell Gage—The gage shown by Fig. 1 is being used to determine whether seasonal variations in the moisture content of the subsoil are likely to cause any movement in the road. The device consists of an invar steel rod encased in a steel tube and anchored in concrete about 6 ft. below the road surface. Movements of the subsoil relative to the top of the invar rod are measured with a dial gage.

Normal Soil Pressure Device—Based on experiments of M. G. Spangler (Iowa State College) in which the pull required to overcome the static friction between a steel tape in contact with either canvas or stainless steel plates embedded between soil and the structure is taken as the measure of the normal force, a device has been developed to measure the normal pressure between a concrete pavement and its foundation by measuring the frictional couple required to turn in its plane a disk bearing on a pressure pad embedded in the soil. This method has the advantage that no long steel tapes have to be installed under the road slab. Preliminary calibration tests in the laboratory have given promising results and experiments are being continued using different pairs of noncorroding metals for the friction elements.

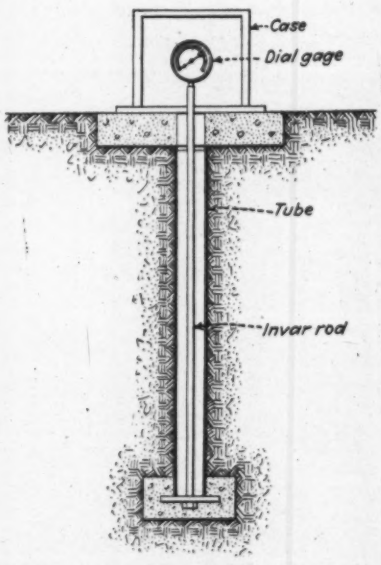

Fig. 1. Subsoil movement due to seasonal change in moisture content are registered on the dial gage by movement of a steel rod set on a buried footing.

Asphalt Beam Test—For making beam tests of coarse-aggregate bituminous mixtures the device shown by Fig. 2 is used. The beams are 16 in. long, 4 in. wide and 2 in. deep. In making a batch of beams, six warmed steel molds are filled from a charge of mixed material, and the specimen is first consolidated with a steel tamper and then rolled to refusal with a 100-lb. 6-in. diameter steel roller. The molds are previously coated with a little soap to keep the beams from sticking. Steel base plates are used to which are screwed steel-angle-irons to form the sides. After the beams have cooled they are removed and tested as shown in Fig. 2. The apparatus employed consists of two parallel steel pegs each $\frac{1}{2}$ in. diameter and 5 in. long projecting horizontally from a heavy steel framework, the pegs being $13\frac{1}{2}$ in. apart, between centers, and lying in the same horizontal plane. A brass sleeve $\frac{5}{8}$ in. outer diameter is slipped over each peg, and being an easy fit, turns as the beam sags. In carrying out the test, the beam is first placed symmetrically on a wooden plank 12 in. long and 4 in. wide and a yoke piece carrying the test load is placed across the beam at the middle. It is then placed squarely on the pegs, the plank is withdrawn, and the rate at which the beam sags is recorded by a pointer on the yoke piece which moves over a vertical scale attached to the steel framework.

Bitumen Viscosity Test—To obtain data on the absolute measurement of the viscosity and elastic properties of bitumens, a Couette type of viscometer has been constructed similar to that designed and used by Dr. Saal of the Amsterdam Laboratory of the Bataafsche Petroleum Maatschappij. This viscometer has

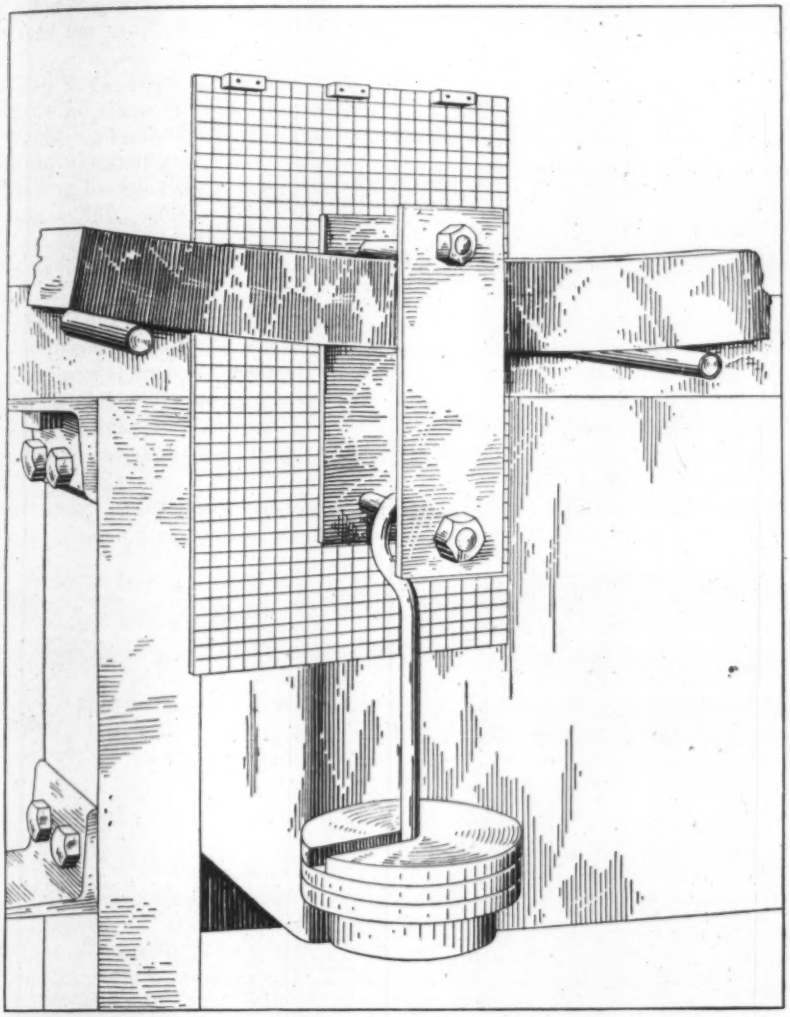

Fig. 2. Apparatus for comparing the bending resistance of beams molded from different coarse-aggregate bituminous mixtures for road surfacing.

been found to be satisfactory and six more are being constructed to a modified design. The instrument consists essentially of a fixed outer cylinder and a concentric inner one which can be rotated by the application of a torque to its central shaft (Fig. 3).

Vertical Tire Stresses—An apparatus developed for determining the normal pressure under a tire is shown by Fig. 4. The principle is to measure the variations in pressure in terms of the changes in electrical resistance of a moulded carbon resistor element $\frac{1}{8}$ in. diameter of the type commonly used in wireless. For a resistor having an initial resistance of 50,000 ohms, the application of an axial load of 1 lb. causes a decrease in resistance of about 18 ohms.

The change in resistance is directly proportional to the load over the range of loads applied and there is no appreciable hysteresis after the element has been loaded a few times.

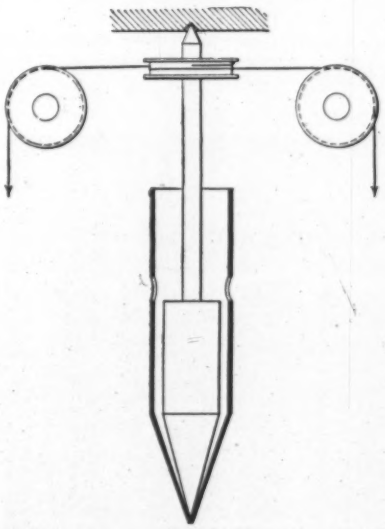

Fig. 3. Viscometer that measures viscosity of bitumen by the torque developed in rotating a conicylindrical body in a bath of the bitumen.

It consists of a plunger A constrained to move only in a vertical direction by means of two phosphor-bronze diaphragms B_1 and B_2. The metallized ends of the carbon element are held in small caps which are inserted between the vertical plunger A and a slow-motion adjusting screw D. The screw D permits the top of the plunger to be adjusted relative to the surface of the plate E.

A wheel carrying the tire is mounted on an axle attached to the upper platform of a 10-ton testing machine while the pressure unit is mounted on a steel plate carried by the lower platen of the machine.

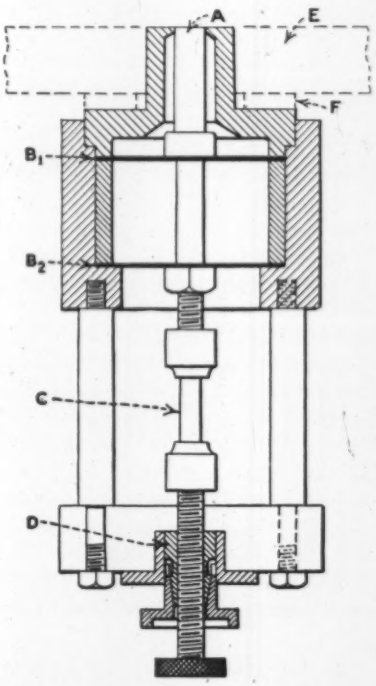

Fig. 4. Vertical tire stresses are measured by changes in the electrical resistances of carbon resistor elements due to the pressure.

The carbon resistor is connected to one arm of a balanced Wheatstone bridge circuit to which a potential difference of 30 volts is applied. Changes in pressure, by altering the resistance of the carbon resistor, upset the balance, which is indicated by the deflection of a galvanometer. Calibration is effected directly by loading the plunger with weights and observing the galvanometer deflections.

FROM FIELD AND OFFICE

Working problems and time-saving methods . . . Edited by Charles S. Hill

Brush Windrows Check Erosion

When high fills are made for new roads on the state highway system in California, if the work is in a location where heavy rains occur, brush cuttings are used to reduce embankment erosion until such time as the new slope can be protected by a grass growth. As embankments are now constructed by rolling the fill material in successive layers, it is possible to place layers of freshly cut brush at intervals as the fill is built. These brush layers are called wattles; a slope so treated is wattled.

To secure maximum compaction a certain amount of moisture ordinarily is required in the fills and this is sometimes sufficient to encourage growth of the cuttings. However, it is not necessarily intended that the brush take root or grow. Its primary function is to prevent any concentration of runoff water in channels and the formation of gullies in the new slopes soon after the fill is completed. The plan is to stabilize the surfaces of these fills by sowing western rye grass upon them in the wet season.

The brush wattles are laid along the face of the embankment with their tops projecting beyond the face, as shown in the accompanying photograph. The fill material then is dumped at the inner end of the brush layer, from which point a bulldozer advances it to its final position.

A bulldozer shoves material over the inner ends of brush laid along the edge of the preceding layer of fill.

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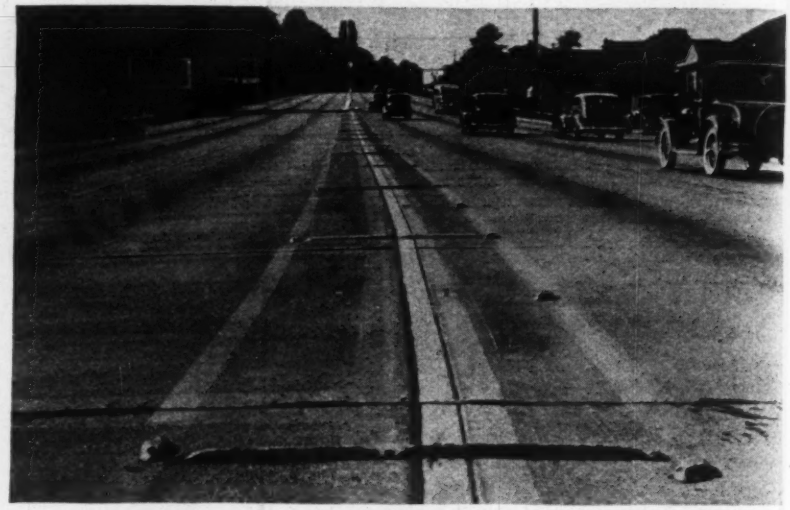
Warning for Wild Drivers

Experiments have been made in Seattle with a safety idea which puts obstructions on the pavement in the center strips that separate opposed traffic. The purpose was to give a danger warning to careless or drunken drivers. The plan has greatly decreased the accidents at safety islands by giving very positive warning to occupants of any car that gets out of the prescribed traffic lanes and heads toward one of the islands.

The first design consisted of pipes set transversely 25 ft. apart for 1,000 ft. each way from a safety island. The pipes were 5 ft. long, 1½ in. in diameter and were flattened at both ends and at the center, with anchor bolts into the pavement at these three points. Concrete mounds also were tried, set alternately with the pipes, using a base width of 4 in. and a height of 1½ in. above pavement surface. The concrete mounds were more satisfactory because they did not rust, required no repainting, and were not knocked out of place as easily as the pipes.

The experiments led to a decision to use precast concrete mounds near



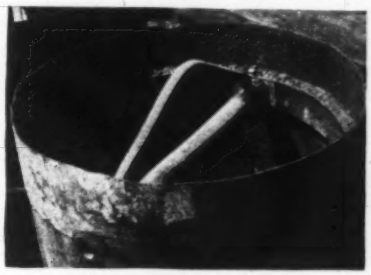
Pipes and concrete mounds made this dividing strip a "jolt zone". Here iron pipes and concrete mounds alternated. Note concrete safety island in the distance. Reflector buttons have nothing to do with the raised obstructions.

safety stations on major thoroughfares. An improved design for the mounds was adopted in which the height is 3 in. and the base width 12 in. This increased height and the greater base width, gives more pronounced indication in a car traveling at high speed, and is expected to make for a durable installation. Instead of the full 5-ft. length used at first, the later design calls for mounds cast in two halves, each 2½ ft. long. Preparation of the pavement for these mounds consists of drilling holes into which dowels can be grouted leaving the upper end projecting. Precast mounds, with holes to take these dowels, are then placed and bedded in grout.

Device For Testing Holding Power of Nails

E. C. SEIBERT
Commander, C.E.C., U. S. Navy
Naval Air Station, Alameda, Calif.

The sketch shows a simple device, giving direct results of practical value, used to determine the holding values of nails, both plain and galvanized, in roof sheathings of different woods, at the Alameda naval air station. For the purpose, it is considered the apparatus gave results of equal value to those which might be obtained with more elaborate apparatus, and more quickly. The sketch, it is believed, is self-explanatory. In the (soft) woods tested, the nails, once started, continued to pull out quickly.



This arrangement stiffened and provided a convenient means for lifting the 3-cu. yd. concrete buckets.

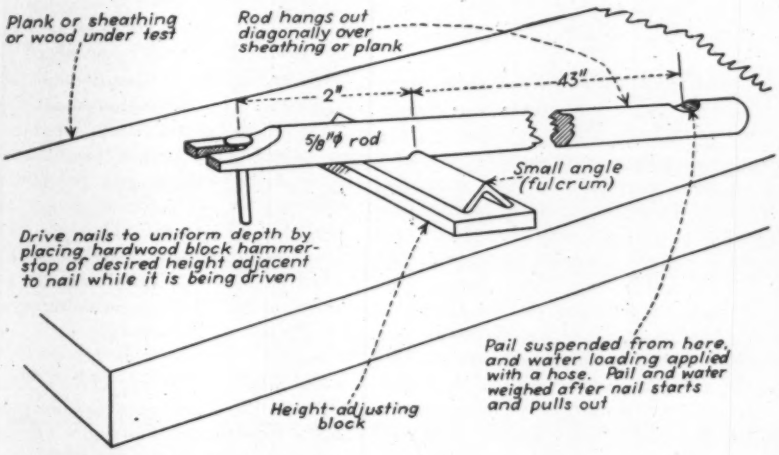

Plank or sheathing or wood under test
Rod hangs out diagonally over sheathing or plank
2"
43"
5/8"ϕ rod
Small angle (fulcrum)
Drive nails to uniform depth by placing hardwood block hammer-stop of desired height adjacent to nail while it is being driven
Pail suspended from here, and water loading applied with a hose. Pail and water weighed after nail starts and pulls out
Height-adjusting block

Diagram showing simple device used to test the holding power of nails.

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A Handy Concrete Bucket

The 3-cu. yd. buckets used for delivering concrete to piers of the Tacoma Narrows Bridge were built with a convenient arrangement for picking them up with the derrick hook. The bucket width was 4½ ft., the depth 8 ft. and the sides were made of ¼-in. plate. Near the top the buckets were stiffened by a 6-in. channel curved to fit and welded into place against the side wall. A 3½-in. extra heavy pipe cut to a length that just extended through the channel and the side wall was then welded to the channel on the inside and on the outer ends to the outside wall. A 2-in. round, solid, mild steel rod, with threaded ends, was attached on the upper side of the pipe; the threaded ends were passed through the pipe to bolts beneath and the junction was welded for additional strength. A bend in the rod automatically centers the lifting hook.

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Seeding Back Slopes

On recent roadwork in New York State after top soil was in place a grain drill was used to spread fertilizer, the gears being set to drill the required amount. The grass seed was sown with a hand sower, the areas being measured to check seed down. After seeding the ground was raked by hand and rolled by using a farm roller pulled by a light truck.

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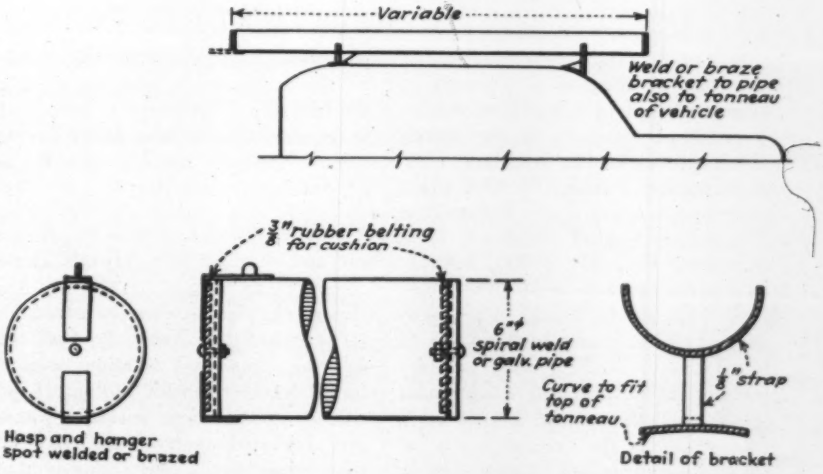
Range Pole Carrier

H. H. ROBERTS
Field Engineer, Okanogan County
Okanogan, Wash.

The accompanying sketch shows the salient features of a metal tube that can be easily mounted on either a private vehicle or a station wagon to carry range poles, level rods, and other bulky field instruments. Note that rubber-belting cushions bolted to end-cover and hinged door are provided to prevent the rods and poles from rattling against the ends and making annoying noises. The device now installed on our field car (Chevrolet Town Sedan) is 8 ft. 3 in. long, allowing for a standard length of 13-ft. folding level rods and 8-ft. range poles. The cost of this carrier including the labor, material, paint, hardware, etc. should not exceed $10 in any locality.


Variable
Weld or braze bracket to pipe also to tonneau of vehicle
⅜" rubber belting for cushion
6"ϕ spiral weld or galv. pipe
Curve to fit top of tonneau
½" strap
Hasp and hanger spot welded or brazed
Detail of bracket

Details of the tube used to carry range poles of the tonneau saddle.

Notes on Sewage Disposal

A monthly summary of current developments conducted by Willem Rudolfs

BRUSH AERATION — Comparisons of different systems of sewage treatment at the same site, using the same sewage, are far more valuable than comparisons of the same systems at different places. At Stockport, England, operation of a Haworth paddlewheel aeration system has been supplemented with a new Kessener brush aeration unit. From results obtained after 15 months' performance of the two aeration systems side by side, it is concluded (*The Surveyor*, March 3, 1939) that the Kessener units have improved the quality of the effluent, and that they are extremely efficient and economical in operation. The sewage contains quantities of trade waste, which are not amenable to primary treatment with chemicals; in order to keep the sludge fresh small quantities of lime must be added to neutralize acid discharges. Conclusions as to efficiency were based on a "work done factor," which is considered a more valuable standard than percentage purification. The factor is calculated by multiplying the volume treated (mgd) by the reduction of oxygen consumed, albuminoid nitrogen and B.O.D. in ppm. Of particular interest is the fact that foul digested sludge could be returned to the influent without detrimental effects.

BETTER FILTRATION—Double filtration, by the use of a roughing filter, followed by a finishing device, is another outgrowth of the search for improvement in trickling filter performance. Laboratory and plant experiments made at the Rothamsted Experiment Station, England, (*The Surveyor*, Feb. 17, 1939) indicate no evidence that rates of flow higher than with single filtration are possible. The uniformly high degree of purification obtained with primary filtration at all rates of flow attempted implies that there is no advantage in this respect. The recirculation of effluent and frequent change-over of the filters invites higher operating cost and more expensive supervision. High rates of flow are known to produce a more even growth of film throughout the filter medium, so that when ponding occurs it is liable to be more serious. High rates tend to diminish the development of fly larvae, worms, etc., which are of importance in keeping the film down and to prevent deterioration of the effluent. High rates in double filtration seem to be impracticable if high purification is desired without nuisances.

SLUDGE DRYING—It has been held by some that in drying sludge on sand beds drainage is more important than evaporation, while others state that effective evaporation is far more important than drainage. From recent investigations (*Annual Report*, Johannesburg, South Africa), it is concluded that about 60 per cent of the total volume of the sludge drains off as effluent. Practically all the effluent drains off in the first 18 hours with a uniform flow. Drainage after 24 hours is negligible, and about 20 per cent by volume is removed by evaporation in a fortnight. The quantity of moisture taken away by evaporation increases gradually, but the rate of increase diminishes with time. From this it is clear that both drainage and evaporation are important to reduce the sludge to a spadable condition, and that about two-thirds of the moisture is removed during the first day. If drainage is prevented it requires 8 to 9 days under sun to remove the same amount of water as by drainage in one day.

CRANKCASE OIL — Crankcase oil and similar mineral oils cause considerable nuisance at sewage treatment plants when received in large quantities. Not only does the oil clog filters and aëration devices, but it interferes with biological activities in digesters, trickling filters and activated sludge units. Laboratory experiments have shown that mineral oils decompose slowly and eventually disappear, producing some combustible gas. Of interest in this respect are the observations made by Jenkins (*Proceedings*, Inst. Sew. Purification, Part I, 41, 1938) in an excavation where previously discarded mineral oil was undergoing extensive decomposition. The rate of decomposition was so great, in fact, that all the ground which had been impregnated had been raised to a temperature of 86 deg. F.; and this was during the winter period. There was no doubt that the decomposition was caused by biological agencies, because the decomposing oil swarmed with molds and *Achorutus*. It might be hazardous to bury waste oil received at plants because of spontaneous combustion dangers.

GAS FROM WASTES—Utilization of mixtures of garbage and sewage sludge for the production of gas used as fuel in automotive vehicles is practiced by the Autonomous Corporation at Foggia, Italy. Operating an experimental plant for a year, using town wastes, gas production amounted to 43.9 liters of gas per kilogram of wastes. The gas contained 82.5 per cent methane with a calorific power of 7,600 calories per cubic meter. The gas is compressed for the use of the trucks.

SLUDGE FERTILIZER — Measured on the basis of available plant food constituents (nitrogen, potash and phosphorus) sewage sludge is a low-grade fertilizer and preferably should be called a soil builder. However, recent research has indicated that sludge should not be judged solely by its content of fertilizer ingredients, because it contains, in addition to these, two groups of substances of value for plant growth. One group includes those organic substances of the hormone and vitamin type which induce root development, stem elongation, ripening of fruit or other responses. In the other group belong those chemicals, extremely small quantities of which are essential for proper development and growth. As a result of an investigation made by Rehling and Truog at the Univ. of Wisconsin, it has been shown that essential elements such as manganese, copper, zinc, boron, cobalt and iodine present in prepared activated sludge give this material a higher fertilizing value than is indicated by usual analyses.

MATERIALS AND LABOR PRICES

Market quotations on construction materials and wage rates reported monthly by ENR correspondents

LUMBER prices provide the most important change in the construction material market for July. Short Leaf Southern Pine is 50c. to $1.00 lower in Atlanta, $1.00 to $6.50 lower in Cleveland; but up $2.00 on most sizes in Detroit, and up 50c. on 1-in. sizes in St. Louis. Douglas Fir is $2.00 to $5.00 higher on most sizes in Boston, and up $1.00 on 1-in. sizes in Montreal. Fir timbers are up 50c. to $1.00 in Montreal.

Cement is 5c. per bbl. lower in New York. Sand is off 15c. per ton in Detroit, and off 10c. per cu. yd. in Los Angeles. Gravel and crushed stone are also 10c. per cu. yd. lower in Los Angeles, and crushed stone is off 10c. in Cleveland. Ready-mixed concrete is down 25c. per cu. yd. in Baltimore and 50c. in Los Angeles, but up 20 and 25c., respectively, in Cleveland and Seattle.

Bricklayers' rates in Cincinnati, formerly ranging from $1.00 to $1.625, closed this gap, and the higher rate now prevails; their new rate in Denver, $1.65 per hr., is an increase of 15c.; and the New York rate, formerly $1.88–4/7, is now $1.90 per hr.

Skilled rates in Montreal are 10c. per hr. higher, except for the structural ironworkers rate, which is 15c. higher. Montreal common building construction labor is up 10c. per hr.

CEMENT, AGGREGATES, READY-MIXED CONCRETE—F.O.B. CITY

	PORTLAND CEMENT			SAND AND GRAVEL			CRUSHED STONE		CRUSHED SLAG		CONCRETE
	Per bbl., carload lots, including 40c per bbl. for bags, cash discount not included			Per ton, carload lots			Per ton, carload lots		Per ton, carload lots, f.o.b. plant		Ready Mixed 1:2:4, 50 c.y. or more, delivered
	Cloth Bags	Paper Bags	Bulk	Gravel, 1½ in.	Gravel, ¾ in.	Sand	1½ in.	¾ in.	1½ in.	¾ in.	
Atlanta	$2.90	$2.65	$2.60	$1.75	$1.85	$1.95	$1.65	$1.75	$1.55	$1.65	$7.90
Baltimore	2.31	2.06	1.86	1.75‡	1.75‡	1.25‡	1.75‡	1.75‡	1.75‡	1.75‡	6.50
Birmingham	2.50	2.25	2.05	1.80	1.80	1.45	1.00	1.00	.90	1.15	5.45
Boston	2.75*b*	2.50*b*	2.30	1.10‡	1.10‡	.80‡	1.10‡	1.10‡	....	....	6.75*m*
Chicago	2.75	2.50	2.35	2.15‡*d*	2.15‡*d*	2.15‡*d*	2.15‡*d*	2.15‡*d*	1.25‡	1.25‡	....
Cincinnati	2.58	2.33	2.08	1.20	1.20	1.30	1.80	1.80	....	....	6.60
Cleveland	2.29	2.04	....	1.45*i*	1.45*i*	1.45*i*	1.60*i*	1.60*i*	1.70*i*	1.70*i*	6.85*i*
Dallas	2.30	2.05	1.85	2.00*p*	2.00*p*	1.50*p*	1.69*p*	1.84*p*	....	....	6.20
Denver	3.02	2.77	....	1.20	1.40	.90	....	....	....	....	7.25
Detroit	2.15	1.90	1.70	1.30	1.40	.80	1.45	1.45	1.14‡	1.14‡	6.50
Kansas City	2.56	2.31	2.16	1.85	2.30	1.00	1.91	1.91	....	....	7.90*n*
Los Angeles	2.82*b*	2.62*b*	....	1.00	1.00	1.00	1.00*f*	1.00*f*	....	....	5.85
Minneapolis	3.00	2.75	....	1.00*h*	1.00*h*	.25*h*	1.00*h*	1.00*h*	....	....	7.35*j*
Montreal	....	....	1.48	....	....	1.25‡	.90‡*c*	1.00‡*c*	....	....	7.60*l*
New Orleans	2.41	2.16	1.96	1.50	1.50	1.25	....	....	....	....	7.25
New York	2.60‡	2.35‡	....	1.40*de*	1.40*de*	.90*de*	1.65*de*	1.75*de*	....	....	7.25
Philadelphia	2.32	2.07	1.87	1.55‡	1.65‡	1.25‡	....	....	1.00	1.00	7.95*k*
Pittsburgh	2.44	2.19	1.99	1.80‡	1.80‡	2.10‡	2.25‡	2.25‡	1.50	1.50	8.75
St. Louis	2.55	2.30	....	1.50‡	1.50‡	1.25/1.50‡	.85*h*	.85*h*	.75*g*	.75*g*	7.50
San Francisco	2.72	2.52	2.20	1.35	1.35	1.35	1.50	1.50	....	....	7.50
Seattle	2.95*o*	2.70*o*	....	1.00*o*	1.00*o*	1.00*o*	2.00*o*	2.00*o*	....	....	7.50*p*

‡ Delivered. *a* 10c. allowed for each returnable bag. *b* 10c. per bbl. off for cash. *c* Plus municipal tax. *d* Per cu. yd. *e* Barge lots alongside docks *f* Crushed granite. *g* F.o.b. Granite City, Ill. *h* F.o.b. plant. *i* Within three miles of Public Square. *j* 5% discount for cash. *k* Discount 35c. 500 to 2000; 70c. 2000 to 5000; 95c. over 5000. *l* Up to 200 cu. yd. *m* 50c. off for cash. *n* 25 c.y. or more. *o* 2% off for cash. *p* 10c. per ton off, cash 15 days.

CASH DISCOUNTS CEMENT to Contractors: truck delivery, 2% for cash on 10th of month; on carload deliveries, no trucking, same as dealer cash discount 10c. per bbl. for payment within 15 days of date of invoice, in Montreal 5% if payment before 15th.

CURRENT MAXIMUM PRICES RECEIVED AT CEMENT MILL

Charge for bags not included. For cloth bags, add 40c. per bbl.; 10c. refund allowed for each returnable bag; for paper bags add 15c. per bbl., not refundable

	Bagged	Bulk		Bagged	Bulk		Bagged	Bulk
Buffington, Ind	$1.70	$1.65	Ironton, Ohio	$1.60	$1.55	Richard City, Tenn	$1.80	$1.75
Dallas, Tex. (Inc. 5c. tax)	1.80	1.75	Limedale, Ind	1.70	1.65	Steelton, Minn	1.80	1.75
Hannibal, Mo	1.70	1.65	Norfolk, Va	1.65	1.60	Universal, Pa	1.65	1.60
Hudson, N. Y	1.75	1.70	Northampton, Pa	1.55	1.50	Waco, Tex. (Plus 5c. Tax in Texas)	1.75	1.70
Independence, Kans	1.70	1.65	North Birmingham, Ala	1.70	1.65			

PAVING BRICK, BLOCKS, ASPHALT, ROAD OILS—F.O.B. CITY

	PAVING BRICKS AND BLOCKS			PAVING ASPHALT		ASPHALT BINDERS—FLUXES		CUTBACK ASPHALT		ROAD OILS	ASPHALT EMULSION (Quick-breaking)
	Granite per M. lots of 50,000 4x4x8 in.	Brick per M. 3x4x8½ in. carload lots	Wood per sq. yd. 3½ in. 16-lb. treat	Per ton, less than 80 penetration		Per gal. 80–300 penetration		Per ton		Per gal.	Per gal.
				Tank car	Drums	Tank car	Drums	Tank car	Drums	Tank car	Tank car	Drums
Atlanta	$75.00	$39.35	$2.25	$16.60*e*	$21.80*e*	$0.0675*e*	$0.0968*e*	$0.0734*he*	$0.1053*he*	$0.0583*e*	$0.0834	$0.0834
Baltimore	140.00‡	44.00‡	2.50	13.00	18.00	.05	.08	.06*h*	09	.....	.....	.....
Birmingham	.....	25.00	.....	18.20	23.40	.0747	.1047	.0834*h*	.1134*h*	.....	.....	.....
Boston	80.00	47.00	3.00	13.00	19.00	.05	.08	.06*h*	.09*h*	.....	.09‡	.12‡
Chicago	140.00	52.00	2.50	14.00	18.00	13.00*g*	17.00*g*	.06*h*	.11*h*	.03	.08	.12
Cincinnati	112.00	37.50	.....	14.31	18.31	.10	.....	18.00	.....	.0523	.....	.08
Cleveland	110.00	37.25	2.80	15.25	20.50	.07	.08	.07*h*	.085*h*	.04	.08	.09
Dallas	.....	30.00	.....	12.00	17.00	.04	.07	13.00	18.00	.035	05/.07	.07/.09
Denver	.....	27.50	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Detroit	.....	35.00	.....	13.60*f*	18.00*f*	.0593	.0994	13.60	18.00	.0535	.0567	.0924
Kansas City	.....	44.00	.....	18.50	23.50	.077	.1075	.077*h*	.107*h*	.057	.11	.15
Los Angeles	.....	50.00	.....	6.50*b*	15.00	6.50*b*	15.00*g*	5.50*b*	.....	.0192	.0525	.1125
Minneapolis	.....	.....	1.90*d*	19.20	24.20	.10	.12	19.30	28.30	.056	.....	.....
Montreal	82.50	.....	3.62	14.60	21.25	.105	.1375	.101*h*	.121*h*	.0935	.13	.16
New Orleans	.....	.....	.....	14.00*a*	19.00*a*	.055	.085	.06*h*	.09*h*	.....	.078	.....
New York	.....	68.00	2.70	13.50	18.50	.055	.08	.06*h*	.09*h*	.....	.07	.10
Philadelphia	120.00	42.50	2.84	14.00	19.00	.055	.08	.06*h*	.09*h*	.05	.06	.09
Pittsburgh	115.00	40.00	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
St. Louis	110.00/121.00	37.00	.....	15.00	20.00	.055	.085	.06*h*	.09*h*	.04	.08	.12
San Francisco	.....	70.00	.....	6.50	15.00	6.50*g*	15.00*g*	7.00	17.50	.025	.0475	.117
Seattle	.....	60.00*c*	.....	13.75	23.55	.....	25.15*g*	10.15/11.15	23.65/24.65	8.40*g*	.0575	.1308

‡ Delivered. *a* F.o.b. Baton Rouge. *b* Delivered to purchaser's warehouse. *c* 3½x4x8½ in. *d* 2½ in. 6 to 8-lb. treatment. *e* Local reduction due to 20% reduction intra-state class freight rates, only Georgia affected. *f* Mexican. *g* Per ton. *h* Per gallon.

IRON AND STEEL PRODUCTS—BASE MILL PRICES

	STRUCT. SHAPES-PLATE	REINF. BARS ¼-in. billet *b*	RIVETS ½-in. structural	WIRE NAILS Base *d*	SHEET PILING Base	STEEL RAILS Per Gross Ton Standard	STEEL RAILS Per Gross Ton Light	STEEL RAILS Per Gross Ton Re-rolled	TRACK SUPPLIES Angle Bars	TRACK SUPPLIES Std. Spikes *c*	TRACK SUPPLIES Tie Plates *c*	TRACK SUPPLIES Track Bolts
Birmingham	$2.10	$2.05	$3.40	$2.45	....	$40.00	$40.00	$39.00	$2.70	$3.00	$2.15	$4.15
Chicago	2.10	2.05	3.40	2.45	$2.40	40.00	40.00	39.00	2.70	3.00	2.15	4.15
Pittsburgh	2.10	2.05	3.40	2.45	2.40	40.00	40.00	39.00	2.70	3.00	2.15	4.15
Buffalo	2.10	2.05	....	....	2.40	....	....	....	....	....	2.15	....
Cleveland	2.10	2.05	3.40	2.45	....	....	....	....	....	....	....	....
Youngstown	....	2.05	....	....	....	....	....	....	....	3.00	....	....
Detroit	....	2.15‡	....	....	....	....	....	....	....	....	....	....
Gulf ports	2.45*a*	2.40*a*	....	....	2.85*a*	....	....	....	....	....	....	....
Pacific ports	2.70*a*	2.50*a*	....	....	2.90*a*	....	....	....	....	3.00	2.25	....

‡ Delivered. *a* F.o.b. cars dock. *b* For rail steel deduct 15c. from billet prices. *c* Other basing points include Portsmouth, O., Weirton, W. Va., St. Louis, Kansas City, Minnequa, Colo., and Pacific coast ports, on tie plates alone, Steelton, Pa., on spikes alone, Lebanon, Pa., Richmond, Va. *d* Add switching charge $18 per c.l.

IRON AND STEEL PRODUCTS—F.O.B. WAREHOUSE, PER 100 LB., BASE PRICE

	STRUCTURAL SHAPES Per 100 lb., base price	REINFORCING BARS Per 100 lb., ¼ in., base price 15 tons or over *b* New billet	REINFORCING BARS Rail steel	REINFORCING BARS Add Switch	REINFORCING BARS $/cwt. for Del.	EXPANDED METAL LATH—Per 100 sq.yd., carload lots Std. diamond mesh, 3.4 lb.	EXPANDED METAL LATH Std. ribbed 3.4 lb.	WELDED FABRIC REINFORCING—Per 100 s.f., carload lots 4x16 in., No. 5 & 10 wires	WELDED FABRIC REINFORCING 4x12 in., No. 8 & 12 wires	WELDED FABRIC REINFORCING 6 & 6 wires Per sq. yd.	SHEET PILING Per 100 lb. base price
Atlanta	$2.34	$2.04	$1.94	.02½	.10	$21.00	$23.00	$1.70	$1.28	$0.1604	$3.04
Baltimore	3.55	2.70	2.55	.....	.10	21.00	23.00	1.58	1.20	.1496	2.70
Birmingham	2.10*a*	2.05	1.90	.02½	.10	19.50	21.50	1.68	1.26	.1586	....
Boston	3.85	2.58	2.43	$20 C.L.	.10	20.00	22.00	1.64	1.24	.1550	2.99
Chicago	2.10*a*	2.05	1.90	.03	.05	18.50	20.50	1.55	1.18	.1460	2.40
Cincinnati	3.88	2.31*c*	2.16*c*	.....	.05	20.50	22.50	1.54	1.17	.1451	....
Cleveland	3.58*g*	2.05	1.90	.02½	.10	20.50	22.50	1.54	1.17	.1460	....
Dallas	4.15	2.80	2.65	.....	.....	25.00	27.00	1.81	1.35	.1712	....
Denver	4.21	3.89	3.74	.....	.....	23.50	25.50	1.85	1.37	.1748	....
Detroit	3.65‡	2.45	2.30	.....	.10	22.50	24.50	1.56	1.19	.1478	2.66
Kansas City	4.03	2.51*c*	2.36*c*	.0	.05	18.50	20.50	1.66	1.25	.1577	2.86
Los Angeles	3.50*f*	2.65	2.50	.02½	.05	23.00	27.50	1.81	1.35	.1712	3.50
Minneapolis	3.80‡	2.38*c*	2.23*c*	.0	.10	21.50	24.50	1.68	1.26	.1586	2.73*d*
Montreal	3.25	2.65	2.55	.....	.....	26.68	29.90	3.03	2.11	.3178	3.95
New Orleans	3.90	2.69	2.54	.05	.10	21.50	23.50	1.71	1.29	.1522	2.875
New York	3.75	2.29	2.14	.....	.10	20.50	22.50	1.60	1.22	.1514	2.74
Philadelphia	3.40	2.37	2.22	.....	.....	20.50	22.50	1.59	1.21	.1505	2.72
Pittsburgh	2.10*a*	2.05	1.90	.02½	.10	21.50	24.50	1.47	1.13	.1388	2.40
St. Louis	3.47	2.29	2.14	.0	.05	23.50	25.50	1.57	1.19	.1487	2.70
San Francisco	3.45	2.50	2.35	.02½	.10	23.50	25.50	1.81	1.35	.1712	3.00
Seattle	2.70*e*	2.40*e*	.....	.....	.....	25.50	27.50	1.81	1.35	.1712	2.90*e*

‡ Delivered. *a* Mill prices. *b* 5–15 tons, add 15c. 1–5 tons, add 25c. Less than 1 ton, add 50c. *c* 20 tons or over Base. *d* Mill price plus freight. *e* F.o.b. dock. *f* Includes delivery in free delivery zone. *g* Less than 1 ton, add 30c.; 1 to 5 tons, add 10c.

PLUMBING, HEATING, WATER, SEWER AND DRAIN PIPE

	C. I. PIPE Per net ton f.o.b. 6 in. to 24 in.*a*	VITRIFIED SEWER PIPE Per foot, 8 in., s.s.	VITRIFIED SEWER PIPE delivered 12 in., s.s.	VITRIFIED SEWER PIPE ASTM 24 in., d.s.	VITRIFIED SEWER PIPE C13–35 36 in., d.s.	CLAY DRAIN TILE Per 1,000 ft., carload lots, 6 in.	CLAY DRAIN TILE f.o.b. 8 in.	CONCRETE SEWER PIPE Per ft., delivered: ASTM 12 in.	CONCRETE SEWER PIPE C 14–35 24 in.	WROUGHT STEEL PIPE Full standard weight, *h* 1 to 3 in., Black %	Butt Weld 3½ to 6 in., Lap Weld Galv. %	Black %	Galv. %
Atlanta	$46.40	$0.26*bc*	$0.468*bc*	$1.69	$4.50*c*	$85.00	$128.00	$0.45	$1.625	62.2	54.2	59.7	51.2
Baltimore	49.80	.30	.55	2.30	6.80	110.00	150.00	.40	1.60	65.5	57.5	63.0	54.5
Birmingham	42.00	.25	.45	1.625	4.66	85.00	220.00	.40	1.60	62.2	54.2	59.7	51.2
Boston	52.00	.245	.4725	1.98	5.535	166.50‡	240.00‡	.45	2.30	64.1	56.1	61.6	53.1
Chicago	50.80	.28	.54	2.25	6.25	100.00‡	150.00‡	.38	1.48	67.0	59.0	63.5	55.0
Cincinnati	49.70	.231	.4455	1.755	5.2275	75.00	120.00	.60	1.90	65.9	57.9	63.4	54.9
Cleveland	51.24	.224	.432	1.665	5.0225	69.00	108.00	.35	1.50	67.8	59.8	65.3	56.8
Dallas	55.20	.27	.486	1.944	4.70	80.00	100.00	.46	1.57	59.9	51.9	57.3	48.3
Denver	57.60	.24†	.52†	2.16†	.....	130.00	240.00	.....	.....	58.4	50.4	55.7	47.2
Detroit	51.24	.147	.2835	1.215	4.70	66.45	111.40	.25	1.125	66.3	58.3	63.8	55.3
Kansas City	52.12	.30	.54	2.16	5.00	120.00	240.00	.45	1.60	62.9	54.9	60.0	51.5
Los Angeles	52.00	.282†	.508†	2.034†	5.085†	115.50	192.50	1.00	2.00	56.8	47.8	54.3	44.8
Minneapolis	54.20	.24†	.432†	1.728†	4.60†	.....	.....	.70	1.80	64.2	56.2	60.7	52.2
Montreal	60.00	.59	.90	3.15	5.10*e*	135.00‡	260.00‡	.48	1.92	.....	.....	.....	.....
New Orleans	48.38	.26	.48	1.69	.....	150.00	220.00	.37	2.10	62.4	54.4	58.8	50.3
New York	49.20	.32	.63	2.52	6.45	.....	.....	.50	1.20	64.9	56.8	62.4	53.9
Philadelphia	47.90	.21	.405	1.75	5.05	100.00	160.00	.54	1.80	65.3	57.3	62.8	54.3
Pittsburgh	52.60	.245†	.4725†	1.845†	5.4325	97.80	154.20	.85*g*	2.00*g*	68.5*i*	60.5*i*	66.0*i*	57.5*i*
St. Louis	49.48	.26	.468	1.872	3.96	70.00	170.00	.80	2.00	65.1	57.1	62.0	53.5
San Francisco	52.00	.3275*d*	.5895*d*	2.358	5.895	107.25	178.75	.45	2.50	.....	.....	.....	.....
Seattle	52.35	.35	.63	2.52	6.30	72.00	175.00	.50*f*	1.40*f*	.....	.....	.....	.....

‡ Delivered. † F.o.b. *a* B. & S. class B and heavier, C/L lots, 200 tons and over Burlington, N. J. (base) $46.00. Gas pipe and class A, $3 per ton additional, 4 in., $3 per ton additional, 30 in. and larger usually $2 per ton less. *b* Double strength. *c* List to dealer. *d* List. *e* 30-inch. *f* Less 5% for cash. *g* Culvert pipe. *h* Discounts from standard list consumers carload prices, except Pittsburgh prices are f.o.b. mill. Base price $200 per net ton. List prices per ft.: ½ in., 8½c.; ¾ in., 11½c.; 1 in., 17c.; 2 in., 37c.; 2½ in., 58½c.; 3 in., 76½c.; 4 in., $1.09; 6 in., $1.92. *i* Applies also at Lorain, Ohio, mills. Chicago delivered base is 2½ points less Freight is figured from Pittsburgh, Lorain, O., Chicago Dist. Billing is from point producing lowest price at destination. WROUGHT IRON PIPE: Base price and list prices per ft. same as wrought steel pipe. Discount for Pittsburgh base: Butt-weld — 1 in. and 1¼ in. black 34, galv. 19; 1½ in. black 38, galv. 21½; 2 in. black 37½, galv. 21. Lapweld — 2½ in. to 3½ in. black 31½, galv. 17½ in.; 4½ in. to 8 in. black, 32½ galv. 20.

LUMBER, TIMBER, PLYWOOD—PER M FT. B.M., CARLOAD LOTS F.O.B.

	SHORT LEAF YELLOW PINE AND DOUGLAS FIR — All S. L. Y. P. is No. 2 common or better and for No. 1 N. C. Box. (Prices in Bold Face) All Fir planks No. 2 common; Fir timber is No. 1 common. Lengths up to 20 ft. (Prices in italics)									LONG LEAF Y. P. Merchantable grade up to 20 ft.		PLYWOOD Rail freight increment (See note for base price)	
	1x6, [a,s]	1x8, [a,s]	2x4, [a,s]	2x6, [a,s]	2x8, [a,s]	2x10, [a,s]	3x12, [a,h]	6x12, [a,h]	12x12, [a,h]	2x12, [a,h]	12x12, [a,h]	3/8"	1/2"
Atlanta	**$19.00**	**$19.00**	**$18.50**	**$19.00**	**$19.50**	**$20.00**	**$27.00**	.....	.....	**$38.50**	**$50.50**	**$17.75**	**$21.60**
Baltimore	**24.00**	**25.00**	**24.00**	**25.00**	**26.00**	**27.00**	**39.00**	.....	.....	68.00	70.00	17.35*g*	21.15*g*
	31.00	*31.00*	*31.00*	*31.00*	*31.00*	*31.00*	*39.00*	***39.00***	***39.00***	.....	.....	.....	.....
Birmingham	**19.00**	**19.00**	**19.00**	**19.00**	**19.00**	**20.00**	**30.00**	**30.00**	**30.00**	.....	.....	16.25	19.85
[i]	22.00	22.00	26.00	26.00	26.00	36.00	54.00	.....	.....	48.00	53.00	.....	.....
Boston	26.00[1]	26.00[1]	30.00[1]	32.00	48.00[1]	55.00[1]	72.00[1]	.....	.....	72.00	72.00	17.35*g*	21.15*g*
	26.00	*26.00*	*30.00*	*32.00*	*32.00*	*34.00*	*40.00*	*40.00*	*40.00*	.....	.....	.....	.....
Chicago	**29.00**	**29.00**	**32.00**	**31.00**	**32.00**	**31.00**	**46.00**	.....	.....	75.00	85.00	13.15	16.05
	33.00	*33.00*	*35.00*	*35.00*	*35.00*	*35.00*	*40.00*	*40.00*	*40.00*	.....	.....	.....	.....
Cincinnati	**23.75**	**23.75**	**25.00**	**23.50**	**24.50**	**26.50**	**37.50**	.....	.....	46.00	49.00	16.25	19.85
	.....	.....	.....	.....	.....	.....	*39.50*	*39.50*	*39.50*	.....	.....	.....	.....
Cleveland *f*	**29.00**	**29.00**	**27.50**	**28.00**	**29.50**	**31.00**	**41.00**	45.00	45.00	50.00	60.00[h]	16.65	20.25
Dallas *e*	**28.50**	**32.00**	**31.50**	**28.50**	**30.00**	**32.50**	**53.50**	**52.50**	**52.50**	63.50	71.00	13.90	16.95
Denver ‡	41.00[4]	39.00[4]	43.00[4]	42.00[4]	47.00[4]	45.00[4]	45.00[4]	56.00[4]	64.50[4]	.....	.....	9.90	12.05
Detroit	**28.00**	**28.00**	**29.00**	**27.00**	**31.00**	**33.00**	**36.00**	.....	.....	31.00	43.00	16.25	19.85
	.....	.....	.....	*36.00*	*36.00*	*36.00*	*37.00*	*43.00*	*43.00*	.....	.....	.....	.....
Kansas City	**27.00**	**28.50**	**28.00**	**26.00**	**28.00**	**30.00**	**35.00**	.....	.....	55.00	58.00	12.25	14.95
	28.00	*28.00*	*28.00*	*28.00*	*28.00*	*29.00*	*34.00*	*35.00*	*35.00*	.....	.....	.....	.....
Los Angeles *a*	*35.00*	*35.00*	*35.00*	*35.00*	*36.00*	*36.00*	*42.00*	*46.00*	*42.00*	.....	.....	9.35*gh*	11.35*gh*
Minneapolis ‡ [b]	43.00[6]	43.00[4]	.....	.....	.....	.....	.....	.....	.....	.....	.....	12.05	14.70
‡	*34.00*	*34.00*	*35.00*	*35.00*	*35.00*	*35.00*	*55.00*	*55.00*	*55.00*	.....	.....	.....	.....
Montreal [7]	*45.00*	*45.00*	*49.00*	*47.00*	48.00	58.00	84.00	.....	.....	135.00	145.00	.....	.....
	40.00	*40.00*	*40.00*	*40.00*	*40.00*	*41.00*	*42.00*	*41.00*	*40.00*	.....	.....	.....	.....
New Orleans	**22.00**	**22.00**	**20.00**	**19.00**	**20.00**	**22.00**	**42.00**	.....	.....	58.00	65.00	13.90	16.95
	26.00	*26.00*	*28.00*	*29.00*	*32.00*	*30.00*	*52.00*	.....	.....	.....	.....	.....	.....
New York ‡	**36.00**	**37.00**	**35.00**	**36.00**	**36.00**	**37.00**	**42.00**	.....	.....	77.50	80.00	17.35*g*	21.15*g*
‡	.....	.....	*40.00*	*40.00*	*40.00*	*40.00*	*40.00*	*42.50*	*42.50*	.....	.....	.....	.....
Philadelphia	**23.50**	**24.00**	**25.00**	**25.00**	**26.00**	**26.50**	**28.50**	.....	.....	54.00	56.00	17.35*g*	21.15*g*
	34.00	*35.50*	*38.00*	*37.25*	*36.50*	*36.50*	*41.75*	*31.50*	*31.50*	.....	.....	.....	.....
Pittsburgh	**38.10**	**39.90**	**47.05**	**42.00**	**45.65**	**46.90**	**59.70**	.....	.....	.....	.....	17.00	20.70
	51.90	*49.60*	*49.60*	*49.00*	*48.90*	*49.25*	*66.55*	*66.55*	*66.55*	.....	.....	.....	.....
St. Louis ‡ *c*	**30.50**	**32.00**	**30.00**	**29.00**	**30.00**	**31.00**	**46.00**	*51.00*	*51.00*	72.00	71.00	13.90	16.95
San Francisco *d*	*19.00*	*19.00*	*19.00*	*19.00*	*19.00*	*19.00*	*23.00*	*23.00*	*23.00*	.....	.....	7.30*g*	8.90*g*
Seattle	*20.00*	*20.00*	*20.00*	*20.00*	*20.00*	*20.00*	*25.00*	*25.00*	*25.00*	.....	.....	0.00	0.00

Bold Face type, Southern Pine. *Italics, Douglas Fir.* [1] Long leaf. [2] Roofers' N. C. Pine. [3] Spruce. [4] Native. [5] Western Pine, No. 3 Common. [7] Pine. [6] Norway Pine. ‡ Delivered. *a* Yard prices. *b* Contractors discount in Minneapolis and St. Paul discontinued May 21, 1938. *c* 5M ft. or less. *d* At ship's tackle. *e* 10% discount taken off.

NOTE: Special concrete form grade Fir Plywood, 4' by 8' panels, 5-ply, sanded 2 sides, water resistant glue, carload lots, delivered per 1,000 sq. ft. surface. Seattle base price on 3/8", $74.00; on 1/2", $81.50; price includes oiling and sealing charges. For other centers add rail freight increment from table for proper size. For resin dipped treatment, add $10.00 per M. *g* Lower rate by water shipment. *h* 50,000 lb. minimum.

GLASS, EXPLOSIVES, CHEMICALS

	WINDOW GLASS — Discounts from jobbers list, Sept. 15, 1928, Single or Double Thickness: A quality	B quality	EXPLOSIVES — Per lb. 40% Ammonia Gelatin in 50-lb. cases delivered in 200 lb. lots*
Atlanta	88%*d*	88%*d*	$0.14
Baltimore	83%*d*	82%*d*	.15
Birmingham	89%	90%	.105
Boston	82%*d*	82%*d*	.15
Chicago	79%*d*	79%*d*	.15
Cincinnati	79–10%*d*	79–10%*d*	.15
Cleveland	85–10%	85–10%	.19
Dallas	80%*d*	80%*d*	.165
Denver	76%*d*	76%*d*	.15*e*
Detroit	79–10%*d*	79–10%*d*	.15
Kansas City	78–10%*d*	79–10%*d*	.155
Los Angeles	88%*a*	90%*a*	.1575
Minneapolis	76%*d*	76%*d*	.155
Montreal	70–10%*b*		.17†
New Orleans	80%*d*	80%*d*	.16
New York	82%*d*	83%*d*	.20*f*
Philadelphia	89–10%	90–10%	.15
Pittsburgh	79%*a*	79%*a*	.1425
St. Louis	79–10%*d*	79–10%*d*	.155
San Francisco	78%*d*	83%*d*	.155
Seattle	85%	88%	.1575

Price of 60% Ammonia Gelatin is $0.015 per lb. higher than 40%

a Disc. from list Sept. 15, 1938 *b* Also less 6% tax exemption. *d* Discount from jobbers' list Aug. 15, 1938.

* Urban prices influenced by service charges or local storage and delivery regulations, do not consistently reflect quantity prices in less congested areas. *e* F.o.b. Louviers, Colo. *f* In boroughs of Kings, Queens and Richmond, and in Manhattan south of Canal Street, add delivery charge of $6.00 per trip. † F.o.b.

40% Ammonia Gelatin price ranges in other than urban areas, per lb. (except Seismograph Grades)

	C/L 20,000 lb. net	Tons	200 lb. lots
E. of the Miss., except Fla.	$0.115	$0.14	$0.16
W. of Miss., to Rocky Mtn. States, and Fla.	.12 –.13	.145 –.16	.165 –.18
Rocky Mtn. States	.12 –.1425	.14 –.155**	.16 –.175**
Pacific N. W. States	.1175–.13	.1475–.16	.1675–.18
Pacific S. W. States	.1150–.1275	.145 –.1525	.165 –.1725

** F.o.b. Louviers, Colo., or Butte, Mont.

PILES, TIES—F.O.B.

PILES

Prices per linear foot, pine, with bark on, f.o.b. New York; delivered from barge 1½ to 2c. per ft. additional:

Dimensions	Points	Length	Short Leaf — Barge	Short Leaf — Rail
12 in. at butt	6 in.	30 to 50 ft.	$0.18	$0.195
12 in.— 2 ft. from butt	6 in.	50 to 59 ft.	.225	.24
12 in.— 2 ft. from butt	6 in.	60 to 69 ft.	.23	.255
14 in.— 2 ft. from butt	6 in.	50 to 69 ft.	.24	.265
14 in.— 2 ft. from butt	6 in.	70 to 79 ft.	.28	.275
14 in.— 2 ft. from butt	5 in.	80 to 85 ft.	.40	.415
14 in.— 2 ft. from butt	5 in.	85 to 89 ft.	.42	.482

RAILWAY TIES

Prices f.o.b., per tie for carload lots:

		6" x 8" x 8' Untr.	6" x 8" x 8' Tr.	7" x 9" x 8'6" Untr.	7" x 9" x 8'6" Tr.
Boston	Oak	$1.10	....	$1.60	....
	Pine	1.40	$2.10*a*	2.10	$3.00*a*
New York	S. L. Sap Pine	1.05/1.15	1.80	1.45	2.35
	Mixed Oak	1.35	1.90	1.85	2.45
Birmingham	White Oak	.85	1.50*a*	1.35	1.70*a*
	Southern Pine	.55*b*	1.10*ab*	.70	1.30*a*
Chicago	Oak	....	1.65*a*	....	2.25*a*
	Southern Pine	....	1.53*a*	....	2.13*a*
Los Angeles	Douglas Fir	.64	1.38*a*	.90	1.80*a*
Philadelphia	Red Oak	1.10	....	....	2.40*a*
St. Louis	White Oak	1.00	....	1.43	....
	Red Oak	1.00	1.50*a*	1.43	1.98*a*
	Sap Pine or Cypress	.90	....	1.33	....
San Francisco	Douglas Fir	.80*bef*	....	....	1.85*caf*
Montreal	Birch or Maple	.65	1.05*a*	.75	1.35*a*

Tr.— Treated; Untr.— Untreated. *a* Creosoted. *b* 6" x 8" x 8'6". *c* Empty cell. *d* Zinc. *e* Green. *f* At ships tackle.

CHEMICALS

Water, sewage treatment, road work, f.o.b. carlots, New York

Bleaching powder, in drums, f.o.b. works, per 100-lb.	$2.00–2.85
Chlorine cylinders, per lb. delivered	.0525
Calcium chloride, 77–80%, flaked, in 400-lb. drums or 100-lb. moisture proof bags, delivered, per ton	22.00–35.00
Silicate of soda, 52 deg., in drums, f.o.b. works, per 100 lb.	1.40
Soda ash, 58%, in paper bags, per 100 lb. dense	1.10
Sulphate of aluminum, commercial, in 100-lb. bags, per ton	23.00
Sulphate of copper, in bbl., per 100-lb.	4.10

STRUCTURAL CLAY BUILDING TILE, BRICK AND LIME—DELIVERED

	STRUCTURAL CLAY TILE — PARTITION — SCORED Per M. lots of 2,000 pieces or over,			STRUCTURAL CLAY TILE — LOAD BEARING — SCORED Per M. lots of 2,000 pieces or over,			BRICK Per M. in quantity.		LIME		
	3x12x12 in.	4x12x12 in.	8x12x12 in.	8x12x12 in.	10x12x12 in.	12x12x12 in.	Common backing	Straight hard	Per ton, Hydrated finishing	In paper Common hydrated	Carload lot, Pulverized or lump
Atlanta	$90.00	$100.00	$185.00	$220.00	$230.00	$240.00	$12.50	$16.00	$24.00	$15.50	$15.50
Baltimore	74.00	80.00	165.00	190.00	240.00	290.00	13.00*k*	16.00*k*	18.00	14.00	2.45*m*
Birmingham	78.75	84.00	157.50	189.00	201.25	242.00	15.00	19.00	3.00*o*	1.75*o*	2.25*lo*
Boston	90.95*ab*	96.95*ab*	181.80*ab*	206.05*ab*	276.65*ab*	316.15*a*	17.00*i*	20.00*i*	20.00	13.00	2.65*lp*
Chicago	68.10	72.60	135.90	185.70	234.90	268.10	11.00	12.00	16.40	14.40	12.20
Cincinnati	61.40	65.30	121.90	141.50	187.30	215.20	16.00	16.00	15.90	13.00	.....
Cleveland	54.50	58.00	109.00	130.50	175.50	200.50	16.00	16.00	16.80*j*	14.00*j*	2.75*jm*
Dallas	62.50	67.00	135.00	162.00	177.00	263.00	11.50*i*	13.50*i*	19.00	15.00	.95*n*
Denver	84.80	95.40	152.70	178.20	212.00	227.90	13.50	17.00	28.00*j*	17.00*j*	35.00*j*
Detroit	68.90	73.50	137.80	175.50	232.00	265.00*e*	15.70	17.00	13.50	11.75	12.75
Kansas City	64.50	66.50	86.00*c*	125.50	159.75	186.25	14.00	24.00	19.10	12.80	10.70
Los Angeles	73.50†*r*	89.50†*r*	128.00*c*†*r*	210.00†*r*	368.00†*r*	460.00†*r*	13.00	15.00	16.50	.....	17.50
Minneapolis	72.60*j*	77.50*j*	132.80	155.00	161.00*d*	225.00*d*	13.10	15.10*g*	21.00	16.00	19.00
Montreal	64.00*a*	77.00*a*	141.00*at*	77.00*a*	128.00*a*	.....	21.00	31.00	24.60	16.00	1.75*lo*
New Orleans	72.00	72.00	135.00	162.00	210.00	260.00	14.00	.....	18.30	12.08	14.10
New York	87.00	93.00	128.00	193.30*h*	238.80*h*	295.60*h*	14.00	.....	20.00	14.00	18.00
Philadelphia	77.40	82.50	154.50	185.70	229.90	284.60	11.00*s*	18.00*s*	15.50*q*	10.05	10.55
Pittsburgh	58.40	62.40	116.85	124.00	153.00	193.75	17.00	25.00	17.90	15.40	2.55*m*
St. Louis	62.00	65.00	120.00	180.00	234.00	280.00	16.00	17.00	22.00	16.00	2.30*lm*
San Francisco	84.00	94.50	225.00	.....	.....	.....	14.00	17.00	.55*o*	.40*o*	2.05*m*
Seattle	100.00	110.00	220.00	.....	.....	.....	17.50*f*	17.50*f*	20.00*s*	20.00*s*	20.00*s*

† F.o.b. *a* Smooth. *b* Carload lots delivered to job. *c* 6 x 12 x 12 in. *d* Not load bearing. *e* 48 lb. tile. *f* Less $1.00, ½ cash 15 days, balance 30 days. *g* Selected common. *h* F.o.b. Perth Amboy, N. J. *i* 50c per M. off for cash. *j* LCL. *k* $1.00 discount if paid in 10 days. *l* Lump. *m* Per bbl., 180 lb. *n* Per sack 100 lb. *o* Per bbl., 200 lb. *p* 280 lb. bag. *q* 15-ton cars. *r* 5% discount 10 days. *s* 2% off cash. *t* 5½ x 8 x 12.

PAINT, ROOFING—F.O.B. CARLOAD LOTS

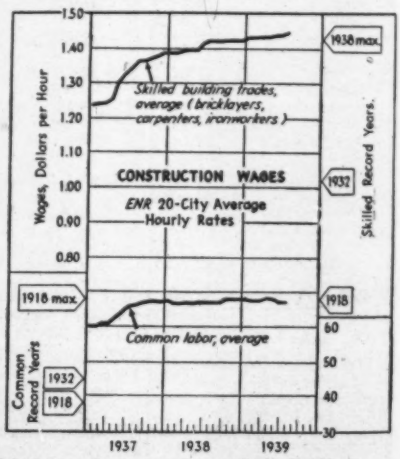
	RED LEAD Per 100 lb. in 600-lb. (Approx.) Dry *a*	WHITE LEAD bbl. Per 100 lb. in oil	READY-MIXED PAINT Per gal., drums Graphite *b*	Aluminum *c*	Ferric Oxide *d*	ROOFING SUPPLIES Carload lots f.o.b. factory Rolls, slate surfaced, 85–90 lb., per sq.	Asphalt felt, per 100 lb.	Tar felt, per 100 lb.	Asphalt coating per gal.	Tar pitch 350 lb. bbl. per ton
Atlanta	$8.50	$12.625	$1.30	$2.25	$1.20	$1.71	$1.65	$1.65	$0.36	$26.00
Baltimore	8.25	12.25	1.60	2.40	1.90	2.16	2.75	2.75	.40	27.50
Birmingham	8.50	12.625	2.35	2.35	1.85	1.84	1.73	1.73	.45	27.00
Boston	8.25	12.25	1.70‡	2.20‡	1.80‡	1.70‡	1.80*h*‡	1.80*h*‡	.40‡	20.00‡
Chicago	8.25	12.25	1.88	2.53	1.56	1.65*hf*	1.49*hf*	1.49*hf*	.26*f*	21.00*f*
Cincinnati	8.25	12.25	1.45	2.50	1.40	2.40	2.39*h*	2.39*h*	.36	21.00
Cleveland	8.25	12.25	1.90	2.60	1.40	1.50	1.50*h*	1.50*h*	.31	21.00
Dallas	8.25	13.00	1.80	1.95	....	2.75*h*	2.50*h*	2.50*h*	.60	....
Denver	8.75	12.75	....	....	....	2.45	4.00	3.00	.35	18.00
Detroit	8.25	12.25	2.00	3.00	1.75	2.40	3.00	3.00	.35	27.50
Kansas City	8.25	12.375	2.15*g*	2.40*g*	1.67*g*	1.93	2.09	2.09	.25	25.00
Los Angeles	8.50	12.75	1.60	2.25	2.30	2.10	1.50	....	.45	....
Minneapolis	8.25	12.375	....	....	....	1.50*i*	1.50*hi*	1.50*hi*	.29	21.00
Montreal	9.75	9.00	2.25	2.80	2.35	3.05	1.85	2.15	.95	10.80*k*
New York	8.25	12.25	1.80	2.45	1.48	1.50	1.50*h*	1.50*h*	.23	24.00
Philadelphia	8.25	12.25	....	....	....	1.92*e*	1.99*he*	1.99*he*	.41*e*	21.00
Pittsburgh	8.25	12.25	1.05	1.95	.80	1.95	1.94*h*	1.94*h*	.34	26.00
St. Louis	8.25	12.25	1.70/1.90	2.50/2.75	1.50/1.90	1.53	1.50	1.50	.23	21.00
San Francisco	8.50	12.50	1.80	2.75	1.10/2.00	1.66	1.90	1.90	.325	20.50
Seattle	8.50	12.75	1.80	3.00	2.20	2.35	1.46/2.14	1.95	.63	24.75*j*

‡ Delivered. Note: Red lead in oil 50c. higher than white lead in oil. *a* Red lead prices change frequently due to pig lead price changes. *b* U. S. War Dept. Spec. 3–49A. *c* ASTM Spec. D266–31. *d* 80% minimum ferric oxide. *e* Subject to 25% discount. *f* Distributors' price to contractors. *g* 5 gal. can. *h* Per roll, 65 lb. *i* Minneapolis and vicinity. *j* Asphalt pitch. *k* 550 lb. barrel.

SKILLED AND COMMON WAGE RATES—PER HOUR

	Bricklayers	Carpenters	Struct. Iron Workers	Hoisting Engineers	Plasterers	Common Labor Building	Common Labor Heavy Const.
Atlanta	$1.25	$1.00	$1.375	$1.00/1.25	$1.25	$0.40/.50	$0.40/.50
Baltimore	1.50	1.25	1.65	1.50	1.25	.5625	.5625
Birmingham	1.50	1.125	1.25	1.125	1.00	.30/.40*a*	.30/.40*a*
Boston	1.50	1.375	1.50	1.375	1.625	.60/.85	.60/.85
Chicago	1.70	1.625	1.70	1.70	1.70	1.025	1.025
Cincinnati	1.625	1.45	1.525	1.00/1.525	1.625	.60/.75	.60/.75
Cleveland	1.625	1.375	1.50	1.50/1.75	1.50	.90	.90
Dallas	1.50	1.00	1.25	1.00	1.50	.40/.50	.40/.50
Denver	1.65*b*	1.50*b*	1.43*b*	....	1.50*b*	.718*b*	.718*b*
Detroit	1.50	1.25	1.50	1.50	1.55	.60/.75	.60/.75
Kansas City	1.625	1.375	1.50	1.50	1.575	.85	.45/.50
Los Angeles	1.25	1.10	1.375	1.125	1.50	.625	.625
Minneapolis	1.375	1.25*d*	1.50	1.40	1.50*e*	.85	.85
New Orleans	1.00	1.00	1.25	1.00	1.00	.40	.40
New York	1.90*b*	1.75*b*	1.925	2.00*b*	2.00*c*	1.031	.875/.95
Philadelphia	1.65	1.25	1.50	1.50	1.565	.60	.60
Pittsburgh	1.75	1.50	1.50	1.25	1.75	.80	.70
St. Louis	1.50	1.25	1.75	1.57/2.00	1.58	.45/.875	.45/.875
San Francisco	1.75*c*	1.25*f*	1.50	1.50	1.60*c*	.81	.65
Seattle	1.60*cc*	1.25	1.50*c*	1.50*c*	1.60*c*	.90*c*	.90*c*
Montreal	.80	.70	.75	.65	.80	.45	.40

a PWA. *b* 7 hr. day. *c* 6 hr. day. *d* 35 hr. wk. *e* 30 hr. wk. *f* Working under "stop-gap" agreement.



ENR Skilled Average: (Bricklayers, Carpenters, Ironworkers) $1.444
ENR Common Average: $0.684